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A RISING INDUSTRIAL PROBLEM; THE NEW APPRENTICESHIP.

By George Frederic Stratton.

We have repeatedly expressed the belief that the provision of "the mechanic of the future" was one of the rising problems of modern industry, too long postponed and soon imperatively to be met. Further reference to this view is made in our editorial pages in this issue. We wish here to call attention especially to the light thrown by Mr. Stratton on the present attitude and policy of the trade unions toward the efforts to recruit the army of trained workers. His interviews with representative New England trade-union leaders, which have been confirmed as printed and are authoritative, show that the old antagonism to the trade school still prevails in the United States, though some change of policy has induced a change of expression so far as public-school manual training is concerned. On the other hand, a most cheering condition is revealed in the present disposition of the unions to encourage shop training for the young mechanic. The manufacturer who is at last becoming interested in the question of training the workmen of the future is thus assured of an open opportunity, free (at least for a while) of union opposition.—THE EDITORS.

FROM the commencement of factory systems, in the early part of the nineteenth century, until the last decade, the boys of the two greatest industrial countries—America and England—have been sadly neglected. The estimation of the value of the apprentice which obtained in the seventeenth and eighteenth centuries almost entirely disappeared upon the introduction of machinery and organized factories. The boy was used, it is true, but only as a factory "cub" and because he could perform some mechanical operation as well as a man, and at greatly reduced cost. He was hired at no better rate of pay than apprentices had obtained, and he was taught nothing but some single operation. In fact, as machines were improved and became more and more automatic, younger boys than ever before—and even girls—were put at factory work and the boy found himself in competition with child labor.

In some shops a few apprentices were still taken on, but their condition was no better than that of the machine boys. The regular mechanics did not look favorably upon them and, as it was nobody's business to teach them, they learned but little. They were the butt of every workman and were considered an unmitigated nuisance by busy foremen; and the employers, hearing of no good results from them, gradually lost all interest in the system (such as it was) so that during the middle of the nineteenth century it was very unusual, indeed, to find a single apprentice in many of the large shops.

The increase in the size of factories, followed by the consolidation of small industries into great central organizations, created a demand for skilled mechanics, foremen, and expert workmen on outside installations and repairs, which could not be met; and the old factory proprietor who had been puzzled by undeveloped and unsettled conditions and who had devoted himself to meeting those conditions as they arose—without much far-reaching preparation for the future—gave way to the industrial manager with great capital, scientifically adjusted organization, and broad, comprehensive views of the future as well as of the present.

Thus it is that the example set ten, eight, or six years ago, by a few great companies, in devising new apprentice systems worthy of the name, is being followed today by a large number of industrial managers, and the interest excited by these systems *per se,* is largely increased by the absolute necessity for obtaining a much greater supply of good, all-round mechanics in every trade.

Some of the manufacturers' associations, notably the National Metal Trades Association and the Machine Tool-Builders' Association, have formulated conditions for apprenticeship contracts upon broad and comprehensive lines for the use of their members.* The present tendency of large employers, however, is to devise special systems which, while embracing practically all of the ideas in the association schedules, contain some additions and modifications, and a review of those systems will show that in almost all cases the conditions and requirements have been studied and met, with the same common-sense progressiveness which so eminently distinguishes American captains of industry.

The system of the New York Central Railroad Company is exceedingly comprehensive and interesting. It starts a boy as an ordinary shop apprentice, on a four-years term; but as he develops his

* The conditions officially approved by the National Metal Trades Association and recommended to its members for adoption were quoted in full in connection with Mr. O. M. Becker's article "A Modern Adaptation of the Apprenticeship System" in THE ENGINEERING MAGAZINE for November, 1906.

abilities and characteristics, he obtains the opportunity to switch off onto other departments, providing he shows indications of becoming more valuable in those departments than in the shops. Thus the shop apprentice, in two or three years, may be transferred to the drafting-room, to the engineering department, or to some division superintendent's department.

A certain amount of night study in various branches is insisted upon; literature and the best of illustrated lectures are continually furnished, and the young men are also transferred, when willing, from one of the company's shops to another, thus affording them varied and valuable experiences.

Complete card records covering the entire course are kept and filed in the Superintendent of Apprentices' office, and every year the following searching list of questions regarding each boy is answered by the foreman or department superintendent, and sent to the apprentice superintendent:—

1. Does he work overtime on drawings or problems?
2. Is he the type of boy we wish to have in our employ?
3. Is his attitude toward his employer good?
4. Does he spend his time well outside of shop hours?
5. Have you (or has the shop instructor) succeeded in gaining his confidence—that is, would he come to you first in trouble of any kind?
6. Can you recommend him, at present, to start in the company's drafting-room, or will he qualify during the present year?—(Give probable date.)
7. What is his strongest point, or for what type of work is he best fitted?
8. What is his weakest point, or for what type of work is he least fitted?
9. Does he live at home, or board?
10. What is his address?

Each year two or three of the best of the apprentices are selected for a two-years technical course, in the line for which they show the greatest promise, and as the expenses are paid by the company, the incentive to excel and to obtain the scholarship with its opening into fields of higher possibilities is very great.

While this plan and the plans of many other employers are meeting with very gratifying success, there are others which are meeting with failure, and which are, for that reason, as valuable for study as those which are more fortunate or of better design.

The apprentice contract of one great industrial company contains the following clause:—

> "The compensation paid to employees by the ——— Company for services, covers inventions, and the undersigned hereby agrees, in consideration of such compensation, that every invention pertaining to the business of the Company conceived or developed by him during such employment, is the property of the ——— Company, and he agrees to make assignment of such inventions to the said Company, on request; the Company to pay the expense of securing the patents."

It is perhaps needless to say that, although this company has splendid equipment and its arrangements in all other respects are excellent for apprentices, it is getting but very few young men to sign that contract. Whatever may be the true view as to the fairness of that clause, it is certain that parents generally are by no means willing that a mortgage shall be given upon their boys' possible ability or chance of inventing something of great value, in return for a recompense averaging 8¼ cents per hour for the four-years course.

The causes of another partial failure are more involved, and perhaps the result is even more unfortunate for the company which suffers by it. The conditions under which its apprentices are received are exceptionally good and liberal. The course is four years. In addition to a rate of 6, 8, 10, and 12 cents per hour for each year, respectively, a bonus of $25 is given at the end of the second year, $50 at the end of the third year, and $100 at the expiration of the term. The instruction covers a very large field, as the works are extensive and contain every description of machine tool, besides a great number of special machines. The boys, also, receive such schooling as is adapted to their needs—arithmetic, elementary mathematics, and drawing sufficient to enable them to read other drawings with facility. The time occupied by this schooling is paid for by the company.

But when the young man has completed his course the failure comes; and in order to understand it clearly it will be necessary to glance at the company's policy regarding all of its employees. The shop is an open one. When any new man is taken on his hourly rate is fixed according to a schedule established by the manager, for all classes of work. The rate, at the commencement, is usually low, but the start is always accompanied by a promise of a raise in a few weeks, if the man's work is satisfactory—a promise which is kept. After that, increases of pay of 2 cents per hour are granted yearly, if the man is worth it, until the limit of good pay is reached.

Now, the way this system operates with the apprentice is this: when his time is out he is receiving 12 cents per hour. If he stays on with the company he is usually given, at once, an advance to 16 or 18 cents, and thereafter the usual raise of 2 cents per hour each succeeding year until he is earning the pay of a first-class mechanic.

This is not satisfactory to the young man. No matter how good a mechanic he is, he has got to serve another seven years before he can command the normal good wage of 30 cents per hour. He is a journeyman as soon as he is out of his time, and he feels that he should, at once, receive a higher rate than 18 cents per hour, which is much less than hundreds of men are getting all about him on machine jobs—men who do not pretend to be machinists and who have never worked, as he has, for four years at a rate averaging 9 cents per hour. Accordingly, he looks for another job (and gets it, with little or no difficulty) and the company loses the man it has spent four years in educating. Of all the apprentices who have finished their course with the company, but 22 per cent have remained with it; a result due to having placed the young journeyman on the same footing as any entirely new employee, and subject to the same inelastic system.

The difficulty, of course, arises from the difference in the points of view between the manager and the man. The manager considers that the young man has received a liberal education and training, and that the company has had, so far, but little profit from his work in return. The quick raise from 12 to 18 cents per hour seems to him to be adequate and even liberal. Moreover, he is naturally unwilling that his established system of periodical and fixed increases of wages up to a set limit for all employees—a system which has worked satisfactorily with thousands of hands for some years—should be broken by a different rate schedule for the apprentice graduate. He feels (and perhaps with good reason) that two methods of advancing pay rates would induce much discontent.

On the other hand, the young journeyman argues that his services for the previous four years have been well worth the wages he has received—that the account, so far, is squarely balanced—and that he should now be considered a mechanic and paid according to his skill and general usefulness. He is by no means willing to make his new start at 18 cents per hour, and under a system which will permit only an annual raise of 2 cents per hour.

"And so——" as Mr. Dooley says, "there yez ar-re!"

In addition to these various and generally very excellent plans for training apprentices in the shops, there has been, in the past decade, a remarkable movement among the authorities of technical schools and the public schools for the establishment of manual-training classes as a part of the regular education. Among industrial managers, however, there appears to be considerable diversity of opinion as to the practical utility of these classes. One who has devoted much

thought and study to the development of an efficient apprentice system said to me:—

> "The technical schools are excellent so long as they confine the studies to the principles of the trades they are teaching. But they, and the grammar schools, can do little or no good to a boy by dabbling in manual training. Neither I nor any other manufacturer would lessen an apprentice course by three months on account of a boy's having been through manual training in his school. It is far better for him to put in that time in rounding out his education; we'll teach him all about the tools."

Another said:—

> "The schools should teach mechanical drawing to every boy who expects to go into an industrial occupation—not in order to make him a draughtsman, but so that he can easily and correctly read regular drawings—a thing which three-fourths of our machinists cannot do, excepting in the case of simple details. These drawing studies would save a lot of valuable time when the boy begins to learn his trade. The manual training will not, I think, amount to much when he gets up against the real conditions."

Some recent communications to the National Society for the Promotion of Industrial Education* give the views of other prominent manufacturers:

R. K. LeBlond, president, R. K. LeBlond Machine Tool Co., Cincinnati, Ohio:—

> "I think it of just as great importance that hands and brain should be educated technically as any other. Any man forfeits a great deal of pleasure and usefulness in this life when his education lacks a constructive course. I do not favor evening schools of any description, while I realize they are an absolute necessity and splendid results are obtained from them. I have always held that it is just as necessary to good health and good results that a certain amount of time be given to recreation as to work, study and sleep."

Henry Hess, Hess-Bright Manufacturing Co., Philadelphia, Pa.:—

> "I favor preparatory trade school work under public-school auspices, but at present in this country these schools usually run to fads. What I have seen of the work turned out and 'pointed to with pride' by the amateurs who run them, is of a most abominably slouchy character which not only fails of its first object but also has a decidedly deleterious influence on the scholars, in giving them the idea that careful and conscientious work is not material. I do not favor trade schools under the auspices of manufacturing concerns as a substitute for the other kind."

* The quotations are extracted from Bulletin No. 3 of the Society—"A Symposium on Industrial Education," containing the contributions of thirty-two employers and labor leaders.

Richard Moldenke, secretary, American Foundrymen's Association, Watchung, N. J.:—

> "I believe that the only hope we have to keep this nation in the front, industrially, is to push industrial education with might and main—and not wait very long before beginning. All trades should be taught. The trade school should teach its students the principles of the respective trades in question, together with enough practical manipulation to make the student self-supporting from the start, after leaving the school. It should also give him a general education, so as not to get the student into grooves."

Frank C. Caldwell, vice president, H. W. Caldwell and Son Company, engineers, founders and machinists, Chicago:—

> "Owing to union restrictions and a number of other reasons, there is very little opportunity for boys to acquire the special training necessary to fit them as practical workmen in some specific trade. We certainly think there is a promising field for a number of such schools. * * * * We are quite certain that the graduates of such schools would be much better equipped as all-round workmen than the average apprentice at the end of his term, or the average workman who has picked up his trade in actual practice. We are inclined to favor the general school as distinguished from the special school."

Any discussion of this vital problem of Industrial Education of course involves the consideration of the attitude of organized labor towards it. And here we are at once confronted with a situation which appears to be exceedingly complicated and difficult; and which is by no means made clearer by the recent change of heart which appears to have affected some of the labor leaders. In 1904 Mr. John Mitchell expressed the following opinion for publication:—

> "It is a regrettable fact that a large number of the graduates from the industrial schools are imbued with a hostile spirit toward trade unionism. In many cases the instruction is of such a nature as to fail to promote sympathy on the part of the boys for the doctrines and customs of labor organizations. This defect should be remedied. No line of cleavage should separate the shop-taught man and the school-taught man. The boys at an industrial school should learn, not a trade alone, but methods for bettering their condition within the trade. I do not believe that graduates of industrial schools will permanently remain outside the trade-union movement; but much needless friction and bitter feeling might be avoided if their instruction were of such a nature as to create in them a sympathetic feeling towards the great trade-union movement."

Mr. Samuel Gompers, in 1905, forcibly expressed the following opinion:—

> "It is not only ridiculous, but positively wrong, for trade schools to continue in their turning out of botch workmen, who are ready and willing, upon their 'graduation,' to take the places of workmen at far below the wages prevailing in the trade. With practically half the toiling masses of our country unemployed the continuance of the practice is tantamount to a crime."

Two years ago the Mason Builders' Union of Boston passed resolutions forbidding any of their members to teach in a trade school.

The late Col. Auchmuty, head of the New York Trade Schools, made this statement shortly before his death:—

> "The American boy has no rights which organized labor is bound to respect. If he is taught his trade in a trade school he is refused admission to nearly all trade unions."

Again, in the annual report of the New York Bureau of Labor, for 1905, the secretary of one of the unions is quoted as saying:—

> "I believe in all journeymen and apprentices being connected with the unions. If a boy becomes a full-fledged mechanic in a technical school he doesn't know anything about unions; nor would he have any sympathy with their rules and regulations."

A large number of other quotations might be cited showing the antagonistic feelings of many union leaders, two, three, and four years ago to trade schools. Now, however, a recent request of the National Society for the Promotion of Industrial Education for the latest opinions on the subject brings forth the following:—

John F. Tobin, general president, Boot and Shoe Workers' Union, Boston:—

> "I am in favor of public education conducted at the public expense, wherein an opportunity is given in the practical workings of any given trade. * * * * * It is frequently said that trade unionists are opposed to industrial education, but this is not true. The opposition which appears amongst trade unionists is because they have in mind the particular private enterprises that have been conducted solely for profit."

John Golden, general president, United Textile Workers of America, Fall River, Mass.:—

> "I can safely say that organized labor is not, and never will be opposed to industrial education properly controlled and scientifically administered.* * * * * Rest assured that the labor unions will, at all times, oppose trade schools of the character I have mentioned" (corporation schools—"scab hatcheries," Mr. Golden calls them) "but will further a movement for more opportunities for industrial and technical education."

John Fitzpatrick, president Chicago Federation of Labor says:—

> "I am in favor generally of industrial education. The form I favor is that of the preparatory and practical. I believe that all trades can be taught. * * * * * I favor preparatory trade school work, under public auspices, but do not favor trade schools conducted by manufacturing concerns."

Henry Abrahams, Secretary Central Labor Union, Boston, Mass.:—

> "Personally, I am of the opinion the trade school is coming, hence we must recognize the inevitable. If we were to take the children of twelve and for two years teach them the use of tools they would find themselves better fitted for the battle of life. There should be evening schools for men in engineering, electricity, plumbing. I am opposed to trade schools run by private corporations."

I. B. Armstrong, master mechanic, L. A. No. 3662, Knights of Labor, Lynn, Mass.:—

> "It would seem that, in order to obtain the greatest results or benefits from trade schools, experience in the trade should be made a condition or prerequisite for admission to trade schools, with the possible exception of the graduates of the public schools in the locality. The limiting of applicants to the school to those already engaged in the business would be necessary in order to prevent the over-crowding of the industry. I do not favor trade schools conducted by manufacturing concerns."

Emma Stehagen, secretary Women's Trade Union League, Chicago, Ill.:—

> "I am in favor of industrial education if carried on in the proper manner, by which I mean, under the auspices of the public schools and giving practical teaching. The trades union movement stands for the uplifting of the worker, and I believe an industrial education is one of the aids of trade unionists. If schools are conducted by manufacturing concerns * * * * they are to be deprecated."

Although these opinions are decided, and in some instances forcible, they are by no means clear excepting as regards the unanimous opposition to instruction courses founded and conducted by the manufacturer. And it was for the special purpose of obtaining an insight into the underlying influences which produce this antagonism to such schools, that I secured interviews with and explanations from several prominent union leaders as to their attitude. The first was with Mr. Abrahams of the Central Labor Union, who expressed him-

self as being deeply interested in the educational problem and desired to put his views in writing. He says:—

> "The trade school is here, and here to stay! Such being the fact, we wage-earners, whose children are to be the workers of the future, are compelled, from the stand-point of self-preservation, to sense this question in all its lights.
>
> "We find that there are many of the large corporations establishing what are termed 'trade schools.' In these establishments the learner is taught but a part of the craft—the school being established for profit to the concern and not for the benefit of the community or the uplifting of the race—and this should be of sufficient weight to prevent the approval of their aims and objects by organized labor.
>
> "Again, there is a suspicion in the minds of some that their object is to build up a wage class.
>
> "We want no class lines in America!
>
> "Regarding the reason raised by some of our business firms, that they cannot secure sufficient skilled help, it is due, in many cases, to the conditions existing in their plants, viz:—long hours and small wages.
>
> "As we are to have these schools, I for one am of the opinion that such institutions run by the State, with no view of profits, but whose sole object shall be the welfare of the student, do not contain the objections that can be urged against private institutions of this nature.
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> "In most, if not all, schools run in the interests of a corporation a boy has to work so long for nothing. As fast as these boys become proficient at any branch the skilled workmen are discharged. Again, those pupils who are not skilled, in the event of strikes for better conditions, can be used as strike-breakers—as was recently done in one case here in Massachusetts."

"What would be the standing, Mr. Abrahams," I asked, "of a boy graduated from a public industrial training school?" The answer was not instantly forthcoming and I added:—"Would he at once take his place as a journeyman?"

"If our committee were satisfied," he answered, "that he was a competent workman he could obtain admission to the union."

"And if he cannot satisfy your committee as to his ability, can he obtain employment, at low wages, so as to acquire experience?"

"Not in a union shop. Of course he can go into an open shop and make any arrangement he pleases."

I went from him to Mr. Tobin, president of the Boot and Shoe Workers' Union, and one of the deepest thinkers on labor problems in New England. He displayed much bitterness (as indeed did every labor man I interviewed) against the trade schools which are run by private parties and for a set tuition fee for the course.

"Such schools," he said, "are for the sole purpose of private gain. A fixed charge, to be paid by the pupil, is required for the opportunity

to apply himself to whichever machine, used in the shoe trade, he desires to learn. The pupil applies himself to this machine, more or less regularly, for a few weeks and the tendency is for him to conclude that he has mastered the machine at an early date and is now qualified to work for wages. In this conclusion he is encouraged by those in charge of the school, as the tendency is to make a place for another pupil who is willing to pay from $25 to $100 for the privilege of learning. The quantities of operators turned out, rather than the quality, is the aim."

"Just what objection is made by labor leaders to the new apprenticeship system which is being established in some great factories?"

"As regards apprenticeship in the shoe trade, the idea of any apprentice system, covering a period of years, is ridiculous. An apprentice who applies himself to the task of learning all the various branches of the shoe trade, instead of being better equipped by the wide range, is positively handicapped—for the reason that he would not be able to acquire the necessary skill and speed to compete successfully with specialists on one branch. In other words, in most mechanical trades the subdivision is so great as to require speed as the principal factor, coupled with skill; which latter is comparatively easy to acquire providing the pupil has a natural aptitude for the line of work in which he has engaged."

"What is your opinion as to the usefulness of manual training in the public schools?"

"I say that an education of that kind tends to train and fix the mind, and better fits the pupil for any calling. The time devoted to manual training better equips the pupil for mental training."

"What chance does a boy so trained have of getting employment in a union shop?"

Mr. Tobin's fine eyes twinkled good-humoredly. "Well," he replied, with some little hesitation, "the locals settle that matter. In Brockton, for instance, they insist upon six-months experience in some other shop before admitting to the shops there."

"And where can he get that six-months experience?"

A shrug of the shoulders and a slight smile preceded the answer: "That is difficult to tell!"

The secretary of the Machinists' Union, at Providence, was extremely bitter against what he called the "catch-penny trade schools." "Look at that!" he exclaimed, as he savagely turned the pages of a magazine and placed his finger upon an advertisement. I read as follows:—"You can get $5.00 a day after a two to three months' course in the plumbing, bricklaying and plastering or electrical trades."

"I'm expecting," said the secretary, "to see an ad. like that about machinists, at any moment! And the half-baked, so-called 'mechanics' they turn out are crowding into the trades and throwing out good men who have served apprenticeship and had large experience."

"What about the new apprenticeship systems which are in vogue in some of the great machine shops—the Pratt and Whitney shops, for instance, or the big locomotive shops?"

"Look here!" he exclaimed, "every one has a motive, and the motive of those big corporations is to obtain, first, a supply of young men, under contract, for four years at rascally low pay, and secondly, to build up a large class of workers so as to have a choice—and also reduce wages."

"How do you feel about manual training in the public schools?"

"Oh, well—that, of course, is all right. I think it is a good thing for any boy to have some acquaintance with tools. It makes him a handy man about the house, you know! Apart from that it is one of the 'fads'—harmless, and about as useless. The unions haven't any quarrel with public-school training. No one supposes that two or three hours a week—monkeying with a few nice tools—is going to make any difference to a boy's start at learning a trade."

Interviews with six other union men, in the machinist, foundry, pattern-making, tool-making and other trades, elicited opinions practically identical with those already quoted. The problem of industrial education resolves itself, in the minds of the union men, into three distinct methods:—the public-school manual training, which they view with a more or less friendly and tolerant feeling; the commercial trade school against which they are extremely bitter; and the four-years apprentice systems of the great corporations, to which they seem to object on general principles. It appears, however, that the objection to the latter is based upon past experience with apprentices who were really cheap producers, rather than upon any clear understanding and appreciation of the present fine systems. Curiously enough, the view of the unions is most graphically set forth by a manufacturer, Mr. Robert H. Jeffrey, vice president of the Jeffrey Manufacturing Co., Columbus, Ohio. He says:—

> "The desire to take advantage of the apprentices, in order to secure the most production from them, has caused the manufacturers to fail in giving them proper instructions to secure mechanical knowledge and efficiency."

The whole situation is further complicated by the charge that the unions hamper shop-apprentice systems by severe restrictions placed upon the number of apprentices to be allowed in any one shop. This

is denied by the union leaders, who emphatically assert that in almost every trade the number of apprentices does not nearly reach the number permitted by the union rules. And their assertion seems to be borne out by some very surprising and quite authentic figures.

The United States census of 1900 shows that the percentage of apprentices to mechanics was but 2.45, while the strictest union allows 7 per cent; many allow 12 per cent. Again, the report of the Massachusetts Commissioner of Labor for 1906 shows that the percentage of apprentices in open shops in that State was no greater than in the union shops.

A thorough investigation made at the instance of the American Social Science Association showed that, out of forty-eight trade unions, having a membership of half a million, twenty-eight with 220,000 members had no restrictions upon apprenticeship. In ten unions, with membership of 197,000, the apprentice limits were fixed at from 7 per cent to 15 per cent. In the other ten the question of apprenticeship was left to the locals.

In the last Trade Census of Massachusetts it is shown that in none of the building trades were there one-half, and in many cases not over one-quarter, as many apprentices as union rule allowed. In 1903 one of the delegates to the Annual Convention of the Pennsylvania Association of Master House Painters and Decorators stated that, after a personal investigation among at least six-hundred master painters, he found that not an average of one in fifteen had a single apprentice in his business, and that the larger the workshop or business, the greater was the dislike of the masters to teaching boys. Also, in corroboration of all this, Professor Thomas Sewall Adams, of the University of Wisconsin, states that only about one strike in three hundred is caused by disputes relating to the apprentice.

This I know; that, whatever their outward expressions of opinion may be, there is among union men a deep, underlying feeling that it is better for the embryo mechanic to be trained in the shops and, in a measure, under the influence of the unions, than in outside schools of any kind. Whenever they become convinced of the absolute good faith of the employers who are introducing the new apprentice systems —when they see that the boys are being trained into the very best mechanics they are capable of becoming, instead of being used, at low wages, as producers—then, I believe, the unions will look with full favor upon the shop apprentice, although it may be expected, of course, that they will always attempt to place and enforce restrictions upon the number employed.

ORGANIZATION PROBLEMS IN STEAM-RAILROAD ELECTRIFICATION.

By Howard S. Knowlton.

Conditions demanding the electrification of steam railways, or dictating the construction of new "heavy" electric lines, will press with constantly increasing force upon the established trunk lines and compel a continuous rise in the rate at which mileage is converted from steam to electric operation. This process will play a large part in the economic and the manufacturing development of the immediate future as well as in the modification of railway affairs. Some of its most interesting and most clearly settled elements—mechanical, as well as functional—will be discussed in the following papers by specialists who are active in the work of reconstruction.—THE EDITORS.

THE electrification of any considerable or important portion of a modern steam railroad is a task of far greater magnitude than is generally appreciated by those outside the organization responsible for the success of the work. To the layman it appears merely a matter of dollars intelligently expended to change the motive power of a railroad from steam to electricity; but to the experienced railroad official the problem bears an entirely different aspect. The selection of suitable equipment in face of the progress being made in all branches of applied electricity is a most difficult question in itself, demanding the highest ability in the consulting engineers retained. The maintenance of an unimpaired service during the transition period is a monumental task; the adjustment of the working personnel to the new conditions; the modification of records and creation of new systems of reports to meet the altered situation in the operating department; the proper installation and adjustment of the power plant, transmission, distribution, and rolling-stock equipment; the protection of the traveling public, safeguarding of the train service, and provision for special repairs and an entirely new kind of inspection, throw a burden upon the railroad company and its advisory experts which can be carried only by a carefully developed organization of trained men, employing the most advanced methods known to the transportation and engineering professions.

At the present stage of electrification development in the steam-railroad field, it is not feasible to present any detailed organization diagram applicable to the general problem, for experience has yet to show the strength and the weakness of the methods thus far applied. It was my privilege, however, in the past summer, to make a careful

study of the operating organizations of three of the most interesting electrifications in the United States, two of them being in connection with heavy terminal and suburban service, and the third an interurban section of a trunk line. In each one of these cases the organization was so different from that in force in the others that the importance of defining the conditions of the general problem became clear, and this article has been prepared in the hope that it will be suggestive as to the relations and possibilities existing and latent in the working system which must be maintained in the successful electrification of a piece of steam-railroad property.

In dealing with problems of organization it is important to realize how profoundly a change in motive power modifies present conceptions of standard railroad practice. It has been well said that the roots of the steam locomotive penetrate every nook and corner of the modern railroad structure, and it is emphatically the case that the displacement of the steam machine by the electric locomotive and the motor car means, in the long run, a revolution in transportation methods, both from the standpoint of the railroad employee and from that of the public. Many of the methods and facilities suitable to steam-railroad operation remain equally acceptable in the *régime* of the electric motor, but in matters of power supply, maintenance, inspection, train handling, and construction, many new conditions must be faced with plans of action depending primarily upon the fundamental differences between steam and electric motive power, and secondarily upon the peculiarities of the local railroad situation.

The essential differences between electrified and steam service have been emphasized so often that they need not be elaborated here. In brief, they are greater capacity to handle traffic, increased comfort, and safety—all being in favor of electric motive power. It remains to be seen whether the actual cost of electrical operation on a converted steam road can be made materially less than that of steam for the same service. If a larger traffic can be handled more safely and comfortably for a given expense, it matters little if the total cost of operation increases, provided the rates are maintained at a level giving a reasonable profit on the investment. This, however, is aside from the divergence between steam and electric practice which stands out so prominently when one views the subject from the railroad standpoint.

The separation of construction work from operating problems is not difficult to carry out in the early stages of electrification. At the time when the change from steam to electricity is begun, the questions at issue are almost entirely constructional in nature. Operation proceeds on the former steam-locomotive basis for many months. If

a railroad company from the beginning adopts the policy of properly separating its construction expenses from its operating costs, and adheres to this policy as its electrification proceeds, endless confusion will be avoided. As the use of electric motors begins and extends, the importance of the construction work gradually tends to decrease, until at last, when a complete electrified section or division is in service, the problem is purely one of operation, including maintenance, so far as that particular equipment and trackage are concerned. This general range of conditions must be faced in carrying through the work, and the organization to handle it on a large scale must be both constructional and operating in its nature if the railroad company desires the fullest control of the situation at every hour of the time required to make the change in motive power. In other words, a large amount of engineering work must be handled, part of it being in the operating field and part in the domain of design and installation. No matter how well qualified any contractor or group of contractors may be to carry out the physical changes in the property, these changes are so far-reaching in electrification and so insistent in demanding the fullest resources of the existing steam organization for successful completion with minimum disturbance of traffic, that the railroad company ought never to yield to any other authority the right of direct supervision within its territory.

The importance of electrification, even of a small section of road, is so great in its relation to future development, that the work as a whole should be in responsible charge of one or more vice-presidents of the railroad company. Where the work involves costly terminal changes in the heart of large cities, or far-reaching modifications in the trunk-line equipment and operating methods, it may be necessary for one officer of this rank to give practically his whole business time to it. In certain cases of the electrification of branch tracks or parallel routes supplementary to the existing trunk-line service, the immediate personal attention of the vice president may not be as essential at every stage of the development. Wherever the work be undertaken, though, many details ought to be deflected from the shoulders of the highest executive officer charged with the responsibility of the task, and allowed to fall upon the organization, which may well be headed by an officer granted supreme authority in the execution of the vice-president's policy and decisions. The title of this officer may be electrical superintendent, assistant general manager in charge of electrification, chief engineer of electric traction, or something else determined by the existing organization and operating conditions.

Fundamentally there is need of an organization, newly created, whose business it is to solve all the problems connected with the actual installation and assembly of the electrical equipment which cannot be handled by the regular organization of the steam road, and to settle those questions in operation and maintenance which are new to the employees of the road on the basis of steam-locomotive operation. Certain very important problems in the design of details fall within the scope of such an organization no less than other important questions in the actual handling of the equipment on the road. They could not be handled by the old staff of the road, for they are almost entirely peculiar to electric service.

It is clearly the part of wisdom to disturb the existing machinery of railroad business as little as possible in carrying out a policy of electrification. So far as the original rules governing train-service employees can be retained, well and good. The probabilities are that in a well-rounded scheme an additional instruction book or two will be necessary to supplement the knowledge of train-service employees. The character of such instructions will obviously depend much upon the character of equipment selected for the service of the road, but the indications are clear that, sooner or later, the train-service men must be given, in comprehensive form, a working handbook covering in detail the methods of handling the electrical rolling stock in regular and emergency operation, outlining the methods of inspection on the road peculiarly electrical in nature, and possibly specifying the essential emergency handling of the distribution system on the right of way. Just how far each class of employees in the general service should be expected to understand the workings of the auxiliary electrical apparatus—auxiliary from the standpoint of train movement—is an unsettled question. Experience may show that it is enough if the electric-locomotive runner understands the general operating rules of the road and the details of his machine; it may show that some knowledge of the rolling stock is desirable for the men in the distribution end, as well as perfect familiarity with the handling of switches and lines, trolley or third-rail appurtenances, with sub-stations and their machinery, if the equipment includes them; or it may show that the best plan is the publication in a single rule book of all the vital operating features of the electrical equipment, from the power house to the motors. There is scarcely any doubt that as electrified operation extends, the importance of giving each man these essentials in black and white will become imperative.

At almost every turn in dealing with the altered conditions in routine operation which result from the greater use of electric motive

power, the question arises, "To what extent shall the engineering organization have jurisdiction over the actual operation of the road?" Upon the answer to this question largely hinges the form of the organization itself. Viewing the matter in the broadest way, it is hard to escape the conclusion that sooner or later the engineering staff must relinquish the direct supervision of rolling-stock operation as such. It may never have been granted supervisory power in this direction, but if it has been, the responsibility for actual train movement is almost certain to be removed from its shoulders. We have here involved the broad question of how far the duties of an engineering staff in any large industrial organization shall be held responsible for pure operation. In the last analysis, the work of the engineer is cast in the field of providing the requisite facilities at the lowest cost consistent with economical service, and of analyzing the actual working of those facilities with a view toward their proper maintenance and maximum economical improvement. Advisory supervision rather than actual handling of equipment and its operators is the logical duty of the engineering organization. Jurisdiction over train movements, then, would seem to belong to the regular operating department headed by the general superintendent.

The character of the equipment is certain to influence the form of the organization to a very large extent. In a system whose power supply is drawn from one or more alternating-current generating plants, with high-tension transmission, and direct-current third-rail distribution from rotary-converter or motor-generator sub-stations, it is out of the question to expect as simple an organization as would naturally be the case on a purely alternating-current system in which no sub-stations are installed. On any electrified steam road the external supply of power calls for an entirely new branch of the operating organization. Power-house employees to the number of several hundred may easily be added to the company's pay roll; line, sub-station and distribution forces add more men who were never before needed in heavy railroad service, and in some cases maintenance of way in the electrical zone calls for a specially developed staff of foremen and subordinates. In some cases the importance of the electrification demands the creation of a new office filled by one or more men who devote their whole time to the broad supervision of the power supply, from the high-tension bus bars in the generating plant to the collecting devices on the electric locomotives and motor cars. Such officials may be designated supervisors of power, load dispatchers, or by other suitable titles. Their work in a system which needs them can be made of extraordinary importance as regards the maintenance of continuous

service, for in them will presumably be lodged the absolute operating control of every ampere of current supplied for transportation service.

Another new branch of the operating organization must be the group of electrical inspectors of rolling stock and the shop forces required to handle repairs on the electrical equipment. One of the most important questions in electrification is whether the electric locomotives (and motor cars, if any) shall be inspected and repaired in the existing shops of the company, or whether new shops and inspection facilities shall be required. There is so little in common between an electric and a steam locomotive that in the opinion of those best qualified to know, the establishment of new and separate facilities is almost a necessity, at least in the early stages of electrification. As the work extends, however, and as fewer steam locomotives are maintained in a given zone, it is sure to become a question how far the old shops can be utilized in the repairs of the new rolling stock. Such a problem cannot be settled off-hand without knowledge of the conditions of operation on a given road. Much depends upon the design of the existing shops, their crane and hoisting facilities, arrangement of inspection pits, machine tools, and store-room facilities. It is certain that many changes in the shop arrangement will sooner or later be needed to handle the repairs of electrical rolling stock with speed and economy, and can these be effected without marring the usefulness of the shops as hospitals for the remaining steam locomotives? Possibly so, for repairs on trucks, frames, and bearings; but the probabilities are that sooner or later complete new shops will be necessary at some central point, designed specifically for the intensified repair work demanded by the new rolling stock, worked as it is ultimately sure to be to the fullest extent of its capacity. However easily a railroad may start off in the use of its electric locomotives, the time will come when the system is forced to the limit of its transportation output, and every hour's delay in making repairs will be regarded unfavorably. Spare parts will be substituted and the rolling stock kept on the road in every possible case, in place of the old policy of holding a whole car or locomotive in the shop pending the repair of a single element of its detail equipment. The new shop facilities may start in a very limited way, or they may be built larger than are at first necessary, and in a permanent location, according as circumstances dictate. The ultimate electrification must always be kept in mind, however, in fixing such a location.

Let us now gather together these considerations and see where they may lead in the organization. We can fairly assume that the train-service organization as a whole will be substantially as before

electrification took place. In place of the engine runner and the fireman, the electric locomotive takes the motorman and his helper; the conductors, baggagemen, brakemen, signal men, station agents, and many other employees have practically the same duties as always. Power supply, maintenance, and inspection are new (or at least different) elements from former steam-locomotive days. Where shall the organization take account of these?

Experience seems to show so far that the train service must remain under the jurisdiction of the general superintendent and his subordinates, the division superintendents. It is not so clear what the final place of the electric power and maintenance forces shall be. The structure of the original steam organization must affect this. Given a vice president in charge of all maintenance, and possibly construction, it would seem that sooner or later the power supply and the electrical inspection and repair work must settle under his jurisdiction. These questions of the final authority of different officials and departments cannot be settled except by experience, but it is clear that the electrical organization must for a time, at least, be held responsible for the installation and proper working of the new equipment. In certain mechanical matters it may be possible to secure the aid of the regular mechanical organization; in other cases, the electrical organization will broadly include both electrical and mechanical supervision

In a general way, the head of the engineering department, certainly during the construction period, will presumably be in charge of the operation of the power-supplying system and the maintenance of electrical rolling stock. Construction matters will also probably be under his jurisdiction. Depending upon the character of equipment, the organization will be divided into sub-engineering departments. All the power supply may be under the jurisdiction of a department head responsible to the chief engineer; in another case, maintenance of rolling-stock equipment, the operation of power equipment, its maintenance and inspection, may be each separately divided. The magnitude of the work is a measure of the scope of subdivision required. The purpose of the new engineering organization must ever be to solve those problems which could not be solved by the existing steam-railroad organization and to co-operate with the regular operating department in securing, first, as good service as was given before electricity came into the field—and better if possible; second, to point out and secure economies in the routine operation of the new motive power; and third, to analyze the daily conditions and service experiences with a view toward improving apparatus and methods for the benefit of future extensions of electrified service.

REINFORCED-CONCRETE BUILDING LAWS; THEIR DIFFERENCES AND DEFICIENCIES.

By H. C. Hutchins.

BUILDING laws controlling reinforced-concrete construction have been prepared by a number of cities in the United States, and it is the purpose of this article to compare them, and to point out the need of a standard building code which should be adopted by all cities.

A great many differences are to be noticed in the codes. Some are complete and definite in their specifications, while others are indefinite and refer everything of importance to the building inspector's decision. This is not a good feature; the laws should specify the requirements clearly, and not leave matters to the decision of men whose tenure of office depends upon political conditions.

The table shown on pages 422 and 423 is compiled from the building laws of New York (where the borough of Manhattan and the borough of Brooklyn have laws differing in many respects), Buffalo, N. Y., Boston, Mass., Chicago, Ill., Denver, Colo., Louisville, Ky., Toledo, O., San Francisco, Cal., Rochester, N. Y., and also from the regulations of the National Fire Protection Association and the Royal Institute of British Architects. Laws are in preparation by Philadelphia, Washington, Pittsburg, Detroit, Cincinnati and New Orleans.

Mixture and Testing.

It will be observed that a majority of cities call for a concrete mixture of one part of cement, two parts of sand, and four parts of broken stone, gravel, broken brick, slag, or cinders. In some cities cinder concrete is prohibited, except by special permit from the building inspector. Limestone should not be allowed, for it has a tendency to disintegrate under the action of heat, and render the concrete of little value in case of a severe fire in the building.

Cinder concrete is liable to contain sulphur, which would have an injurious effect upon the reinforcing steel. It should not be used in building work unless the percentage of sulphur is very low, and then only when the cost of rock concrete is so high as to prohibit its use. Rock concrete is so much better that it should always be speci-

TABLE SHOWING REQUIREMENTS OF BUILDING CODES.

	New York, Borough of Manhattan.	Borough of Brooklyn.	Buffalo, N. Y.	Boston, Mass.	Chicago, Ill.	Denver, Col.	Louisville, Ky.	Toledo, Ohio.	San Francisco, Cal.	Royal Institute of British Architects.	National Fire Protection Association.	Rochester, N. Y.
Kind of cement	Portland	Portland	Portland	Portland	Portland	Portland	Natural or Portland	Portland	Portland	Portland	Portland	Portland
Test tension, lb. (1 day in air. Neat briquette)	per sq. in. 300	175	.....	.....	200	200	.....	300	.....	.....	300	.....
Test tension, lb. (1 day in air. 6 days in water)	500	500	500	.. ..	500	500	.....	500	.....	.....	500	.....
Test tension, lb. (1 day in air. 27 days in water)	600	600	600	.....	600	600	... . . .	600	... .	.....	600	.....
Tests (Fineness, constancy of volume, etc.)	A. S. C. E.	Special rules	A. S. C. E.	.....	A. S. C. E.	A. S. C. E.	A. S. T. M.	A. S. C. E.	.....	.....	A. S. C. E.	....
Concrete mixture	1-2-4	1-2-4	1-2-5	1-5	1-3-5	1-2-3	1-2-4	1-2-4	1-3-5 and 1-2-4	.....	1-3-5	1-2-5
Method of mixing	Wet	Wet	Wet	.. ..	Wet	Wet	.....	Wet	Wet	.....	Wet	.....
Size of stone, in. (Foundations, columns, slabs.)	¾	2 in. ¾	¾	.....	¾	2 2 ¾	2 1½ 1	¾	2 1 1	¾	¾	2
Concrete test (Compression after 28 days per sq. in., lb.)	2000	2000	2000	2000	.....	.....	... .	2000	2000	2400	2000	.....
Extreme fibre stress per sq. in. for concrete in compression, lb	500	500	500	500 to 600	500	500	700	500	500	600.	500	... .
Concrete in tension per sq. in., lb	None	None	None	None	None	None	None	None	None	None	None	None
Concrete in direct compression, lb	350	400	350	350	350	450	700	350	450	500	350	230
Shear in concrete per sq. in., lb	50	75	50	60	75	50	30	50	75	60	50	.....
Adhesion of concrete to steel, lb	50	75	50	60	75	75	30	50	75	100	50	.....
Ratio of modulus of elasticity	1/12	1/12	1/12	Beams & slabs 1/15, col. 1/10	1/12	1/12	.....	1/12	1/12	1/15	1/15	.....
Column stress, lb. (Horiz. hooping)	350	600 to 750	.....	.....	. .....	.....	.....	700	.....	.....	6000S 350C	.....

Column stress, { Spiral / lb. { hooping }	Special formula	1000C 8000S	.....	.....	....	.....	.....	.....	700	.....	.....	.. ..
Columns, ratio of height to least diameter.....	$\frac{1}{12}$	$\frac{1}{13}$	$\frac{1}{16}$	120 times least rad. of gyr.	$\frac{1}{12}$	$\frac{1}{11}$	.....	$\frac{1}{12}$	$\frac{1}{13}$	.....	$\frac{1}{12}$	.....
Insulation—Columns, in...	. .....	2	.....	1½	Diam. of bars.	1½	2	.....	1½	2	4 times diam. of bar to 4″	.....
" —Beams, in.	.....	1½ times diam. of bars to 1½ in. max.	.....	1½	.....	1¼	.....	.....	1½ times diam.	1½	4 times diam. of bar to 4″	.....
" —Slabs, in.....	.....	1½ times diam. of bars to 1½ in. max.	.....	¾	.....	½	.....	.....	1	1	1	.....
" —Walls, in	.....	Diam. of bars to 1 in. max.	.....	.....	.....	.....	.....	.....	1	1	.....	.....
Tensile stress per sq. in. for steel, lb.....	16000	16000	16000	16000	⅓ of elastic limit	⅓ of elastic limit	12000 to 18000	16000	⅓ of elastic limit	15000 to 17000	⅓ of ultimate strength	16000
Shear stress, for steel, lb...	10000	10000	10000	10000	10000	10000	10000	10000	10000	.....	10000	10000
Spacing of hoops in columns.....	Least width of col.	1½ times least width of col.	Least width of col.	.....	Least width of col.	Least width of col.	.....	Least width of col.	Least width of col.	.....	Least diam. of col.	... .
Minimum thickness of concrete slabs, in.....	.....	3½	....	....	.....	.....	.....	.....	3½	....	.....	....
Width of slab allowed for figuring tee beams.....	10 times width of beam	10 times width of beam	10 times width of beam	⅓ span of girder	5 times depth of slab	5 times width of girder	.....	10 times width of girder	5 times thickness slab	⅓ times beam span	.....	.....
Deflection allowed on load test.....	3 × load no sign of failure	Twice load $\frac{1}{700}$ def.	3 × load no sign of failure	.....	Twice load $\frac{1}{700}$ def.	Twice load $\frac{1}{700}$ def.	.....	3 × load no sign of failure	Twice load $\frac{1}{700}$ def.	.....	.....	.....
Bending moments—Beams.	$\frac{W\,L}{8}$	$\frac{W\,L}{8}$	$\frac{W\,L}{8}$	Contin. $\frac{W\,L}{10}$	$\frac{W\,L}{8}$	$\frac{W\,L}{8}$	.....	$\frac{W\,L}{8}$	$\frac{W\,L}{8}$	$\frac{W\,L}{8}$	$\frac{W\,L}{8}$	.....
Bending moments—Continuous slabs.....	$\frac{W\,L}{10}$	$\frac{W\,L}{10}$	$\frac{W\,L}{10}$	$\frac{W\,L}{10}$	$\frac{W\,L}{8}$	$\frac{W\,L}{12}$	.....	$\frac{W\,L}{10}$	$\frac{W\,L}{12}$	$\frac{W\,L}{12}$	$\frac{W\,L}{10}$	.....
B. M. for slabs supported on all four sides.....	$\frac{W\,L}{20}$	$\frac{W\,L}{20}$	$\frac{W\,L}{20}$	.....	$\frac{W\,L}{20}$	$\frac{W\,L}{20}$	.....	$\frac{W\,L}{20}$	$\frac{W\,L}{20}$	.....	$\frac{W\,L}{20}$	.....
Maximum percentage steel in beams.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Minimum percentage of steel in columns.....	.....	$\frac{1}{200}$	.....	.....	.....	... .	....	.....	... .	.....	.....	.....
Time of removal of centering for columns....	..... .	.....	.....	.....	.....	4 days	10 to 15 days	.....	.....	8 to 28 days	1 to 60 days	7 days
Time of removal of centering for beams	... .	.....e	.....e..	.....	.....	12 days	14 to 21 days	.....	.....	Depending on	Depending on	.....
Time of removal of centering for slabs.....	.....	.....	.....	.....	.....	6 days	10 to 15 days	.....	.....	weather condi'ons	weather condi'ons	.....

fied for columns, beams, and slabs, using cinders only for filling between the wooden sleepers in floors, for grading under basement floors, or for grading roofs. Cinder concrete has been used for floor slabs between steel beams, when the spans are short, but it does not possess the strength of rock concrete and its use should be limited by the codes.

THE POST AND OFFICE BUILDING, GRAND CENTRAL TERMINAL, NEW YORK CITY. SHOWING CONCRETE FIREPROOFING OVER STEEL CONSTRUCTION.

Reed & Stem and Warren & Wetmore, associated architects; the Roebling Construction Co., contractors.

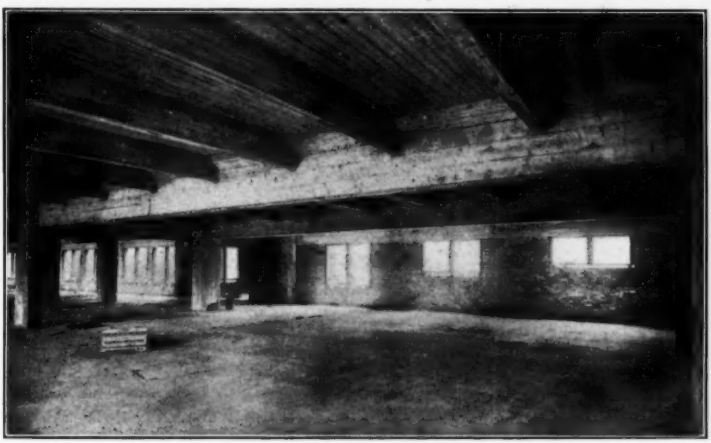
The quality of the rock is important, and should be carefully looked into on all work. Rock containing much mica should be prohibited, for the particles of mica offer cleavage planes for the concrete to shear on. A good quality of crushed granite or other hard and sound stone not containing lime, mica, sulphur, phosphorus, or other elements in quantities liable to injure the steel or the strength of the concrete should be used. Gravel may be used when it is clean and free from clay or loam, which tend to form inert spots in the concrete.

All stone for foundations of concrete should be broken into sizes that will pass through a 2-inch ring in any direction. For floor slabs, beams, girders, columns, or walls, the size should be between ¼ inch and ¾ inch, so that when the concrete is poured wet the particles of

stone can pass between the reinforcing metal without clogging the flow, and the concrete can reach every part of the forms.

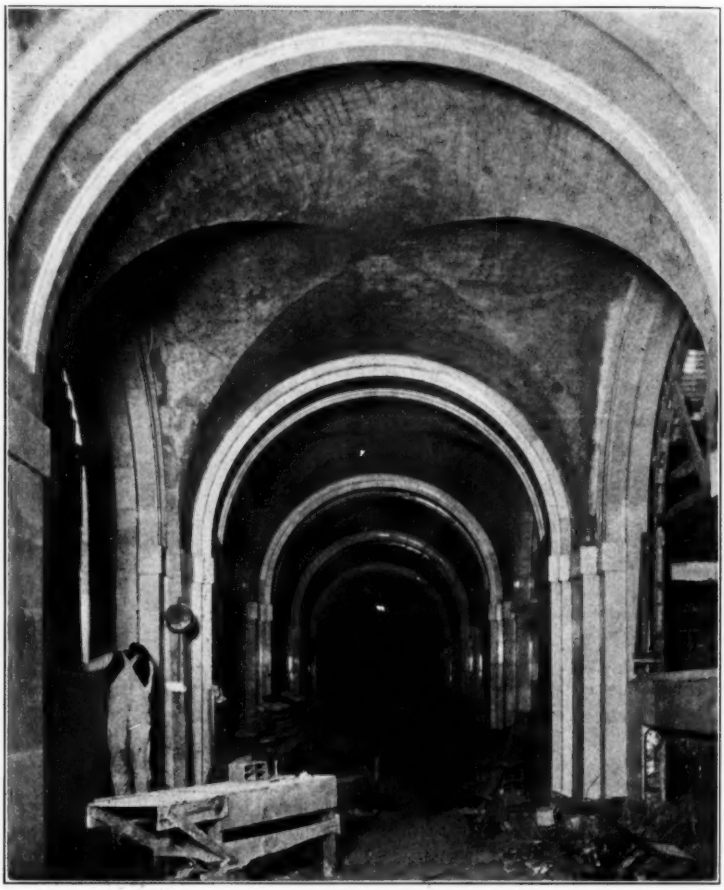
Testing.

Most cities refer the standards of testing the cement to the specifications of the American Society of Civil Engineers, or those of the American Society for Testing Materials. These standards have been carefully worked up, and are excellent. Samples of the cement should be tested at frequent intervals during the construction of any concrete work, so that any defects in quality may be discovered, and the cement rejected if not up to the required standards. Too little attention is paid to the testing of the materials of construction in concrete at the present time. Concrete is used by thousands of contractors who never test their cement at all, simply throwing it in as it comes from the mill, and sacrificing all tests and analyses to the desire for "speed of construction." Some contracting firms make a special point of this and advertise their construction records widely.



INTERIOR OF BUILDING FOR AMERICAN OAK LEATHER CO., CINCINNATI, OHIO, SHOWING 50-FOOT SPAN IN REINFORCED CONCRETE.
The Ferro-Concrete Construction Co., Cincinnati.

Failures of concrete construction have been due solely to extreme speed of construction and a lack of care in making tests of the cement and concrete. There is no reason why structures of this character should fail, provided the work is in the hands of intelligent engineers who test the cement and concrete and see that the work is done according to the specifications. Important concrete construction requires the services of trained experts, and should not be left



MAIN FLOOR CORRIDOR, COOK COUNTY COURT HOUSE, CHICAGO. SHOWING CONCRETE CEILING CONSTRUCTION.

Holabird & Roche, architects; the Roebling Construction Co., contractors.

solely to the contractor, as his main interest is to erect the building in the shortest possible time so as to increase his profits. This craze for "speed of construction" has produced failures which have hurt the concrete business, by producing a feeling of distrust in the minds of prospective builders, and the steel construction advocates have used these failures to produce business for themselves by advertising them widely.

Insulation.

Insulation for the reinforcing steel calls out many differences. Some codes specify that there shall be a thickness of concrete equal to the diameter of the bars used. This rule is dangerous, for if very small rods are used, down to ¼ inch or less, the insulation becomes very thin. According to that ruling, if expanded metal were used for reinforcing the thickness underneath the metal would be not much thicker than a mere coat of plaster, which would afford very slight protection against a hot fire heating and damaging the steel reinforcement. A rule requiring a certain definite minimum thickness of one inch, as called for by the National Fire Protection Association, The Royal Institute of British Architects, and others, affords a proper protection against damage by fire.

In the insulation of the reinforcing bars of columns and beams, the rules vary from 1½ to 4 inches, which latter seems excessive. Two inches should be specified, outside of all reinforcing steel, and no account should be taken of this covering in figuring the stresses, as in case of fire it would be liable to spall off and become useless for carrying loads.

Stresses in Concrete.

A majority of codes specify that 500 pounds per square inch is high enough to figure the extreme fibre stress for compression of concrete in beams and slabs. The British Architects call for 600 pounds. Concrete in tension is rejected by all the above codes, and should be, for the steel in tension in beams does not begin to take its stress properly until the concrete has developed fine cracks, and therefore has failed by tension before the steel begins to be stressed.

Concrete in direct compression takes values of 350 to 700 pounds per square inch. The former is too low for 1—2—4 mixture testing from 2,000 to 2,400 pounds per square inch. A factor of safety of four would allow 500 to 600 pounds, the former of which is not excessive for columns properly hooped.

Columns.

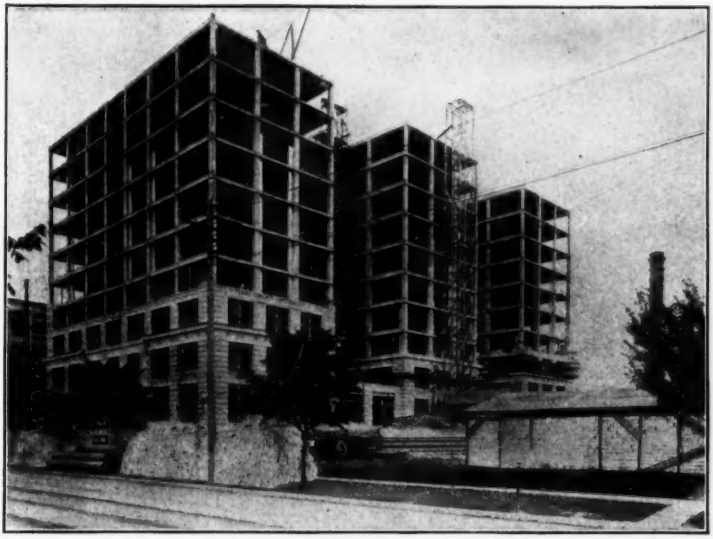
The greatest differences in the codes is in the question of allowable stresses for columns. The requirements range from 350 to 1,000 pounds per square inch on the concrete inside the hooping. Many codes do not specify any values for allowable stress, leaving it to the judgment of the building inspectors. A more uniform range of stresses should be specified. Columns limited to 350 pounds per square inch soon become excessively large in high buildings. For example let us take the case of a warehouse, with 200 pounds per

square foot live load on floors and 100 pounds dead load, twelve stories high, with floor panels of 16 by 20 feet (or 320 square feet) bearing on each column, comparing the rule of 350 pounds with 500 pounds and 750 pounds per square inch on the concrete inside the hooping, figured for the reduction of live load allowed by the New York Code as follows:

> "For the roof and top floor the full live loads shall be used; for each succeeding lower floor, it shall be permissible to reduce the live load by five per cent (5%), until fifty per cent (50%) of the live loads fixed by this section shall be used for all remaining floors."

No column diameter is taken less than 1/12 of the height, making the roof columns 12 by 12 inches. For the purposes of this comparison the weight of the column itself is neglected, as it forms only a small percentage of the total weight. The column sizes are taken to

THE GRETSCH BUILDING, OF REINFORCED CONCRETE, BROOKLYN, N. Y.
Benj. Finkensieper, architect; P. R. Moses, consulting engineer; Turner Construction Co., constructors.



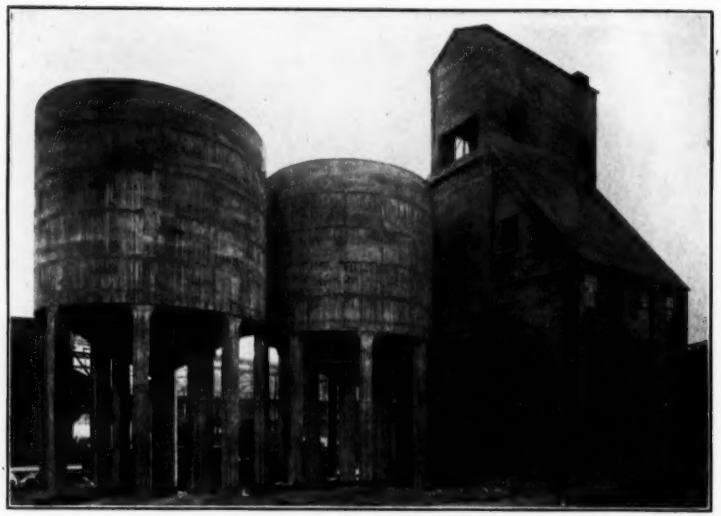
FACTORY BUILDINGS IN REINFORCED CONCRETE, FOR THE NATIONAL CASH REGISTER CO., DAYTON, O.

Built by the Ferro-Concrete Construction Co.

the nearest inch, fractional dimensions being disregarded. With columns figured at 350 pounds for a load of 928,000 pounds, the size in the basement becomes 51 by 52 inches, or 18.4 square feet., which is 5¾ per cent of the total area of the floor panel. At 500 pounds the size is 43 by 43 inches, or 12.8 square feet., which is 4 per cent of the total area of the floor panel. At 750 pounds, the size is 35 by 36 inches, equal to 8.75 square feet, or 2½ per cent of the total area of the floor panel.

The tests made at the Watertown Arsenal show that on columns reinforced with vertical rods and made of 1—2—4 concrete, the ultimate strength ranged from 1,990 pounds to 3,160 pounds per square inch, with an average of 2,350 pounds. Taking the lowest value, and using a factor of safety of four, we get $1{,}990 \div 4 = 497$, or practically 500 pounds for the allowable stress per square inch on this form of column.

Concrete in columns gives notice of approaching failure by the spalling off of pieces of its covering over the reinforcing steel. Total failure produces a breaking out of the concrete through the spaces between the hooping. This indicates the desirability of decreasing the size of the spaces between the hooping, which is done by winding the column outside the vertical rods with a spiral hooping composed



SAND BINS AND DRYER HOUSE OF REINFORCED CONCRETE FOR J. B. KINGS & CO., HEMPSTEAD HARBOR, L. I.

Turner Construction Co.

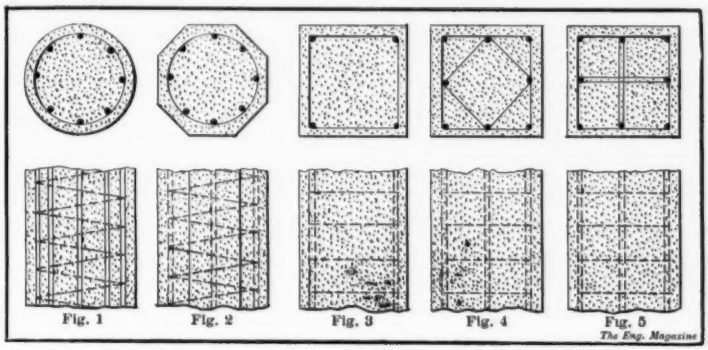
of wire or flat bands. Flat bands offer a broader surface to the concrete with less thickness than round-wire hooping, leaving less space for the concrete to break out between the coils of the spiral.

M. Considere's experiments upon the strength of spirally hooped columns show that spirally hooped columns with vertical rods will stand pressures of 4,550 pounds to 5,400 pounds per square inch before total failure. With a factor of safety of four, loads of 1,100 to 1,200 pounds per square inch on the concrete inside the hooping can be used. One building department code allows 1,000 pounds per square inch on the concrete and 8,000 pounds per square inch on the steel. This rule, however, does not appear in the code, but was learned by consulting the department engineer. Using this rule for the case of the twelve-story building, we find that the largest column required, using for vertical reinforcing eight (8) 1¼-inch rods, as follows:

Total load	928,000	lb.
Load carried on steel rods, 8 by 1.22 by 8,000 lb.	78,080	"
Load to be carried by concrete	849,920	"
Area concrete required at 1,000 lb. per sq. in.	849.92	sq. in.
Diameter of concrete column required	32.9	inches.

This form of column will give the smallest size, and the size can be decreased further by using larger vertical reinforcing rods, as the steel is allowed 8,000 pounds per square inch, while the concrete has only 1,000 pounds per square inch.

The hooping of concrete columns must be made in such a way that every vertical rod is prevented from moving outward. This may be done best by making the columns circular or octagonal in shape, as in Figures 1 and 2.



REINFORCEMENT OF CONCRETE COLUMNS.

Spirally hooped columns should be made either round or octagonal. Horizontally hooped columns may be made with any of the arrangements of hooping shown above, and should have the vertical rods attached by a light wire to each rod, so that the steel will remain in place in the forms during the process of pouring the concrete. When the column becomes large enough to require eight vertical rods, as in Figures 4 and 5, an extra hoop binding the intermediate rods together should be used, for otherwise these rods are not confined sufficiently to prevent a displacement of an inch or more before the hooping acts upon them; and then it would be useless, for the concrete enclosed within the hooping would be distorted to a dangerous extent.

The spacing of the hooping in columns is specified in a majority of cities as not to exceed the least width of the column. Many contracting firms use a standard spacing of 12 inches, varying the size of wire where necessary. The codes themselves do not specify clearly the exact stresses and arrangement allowed on columns, and as a result columns have been passed by building departments where the stresses on the concrete have been as high as 1,200 pounds per square inch. The question of the proper stresses to place upon both the steel

and concrete should be governed by some definite rule regarding the minimum amount of steel allowed in the column. One code only has a rule governing this, and that is:—

> "The total cross-sectional area of the reinforcing bars shall in no case be less than 1/260 of the total cross-sectional area of the column."

When the hooping is used in columns, it should be of sufficient size and strength to prevent it becoming bent, for if it is not stretched tightly around the rods, it cannot act properly in binding them.

Many codes require a pipe sleeve to be placed to cover the joints of the vertical rods, ⅛ inch larger than the rods, so that it can be grouted with cement mortar. A better method would be to specify sleeve nuts, which would insure positive action when the joint is called upon to resist tension caused by wind pressure. This is the most satisfactory method, but is more expensive than grouted pipe sleeves, or the method of overlapping the rods and clamping them, or winding the overlapping ends with wire.

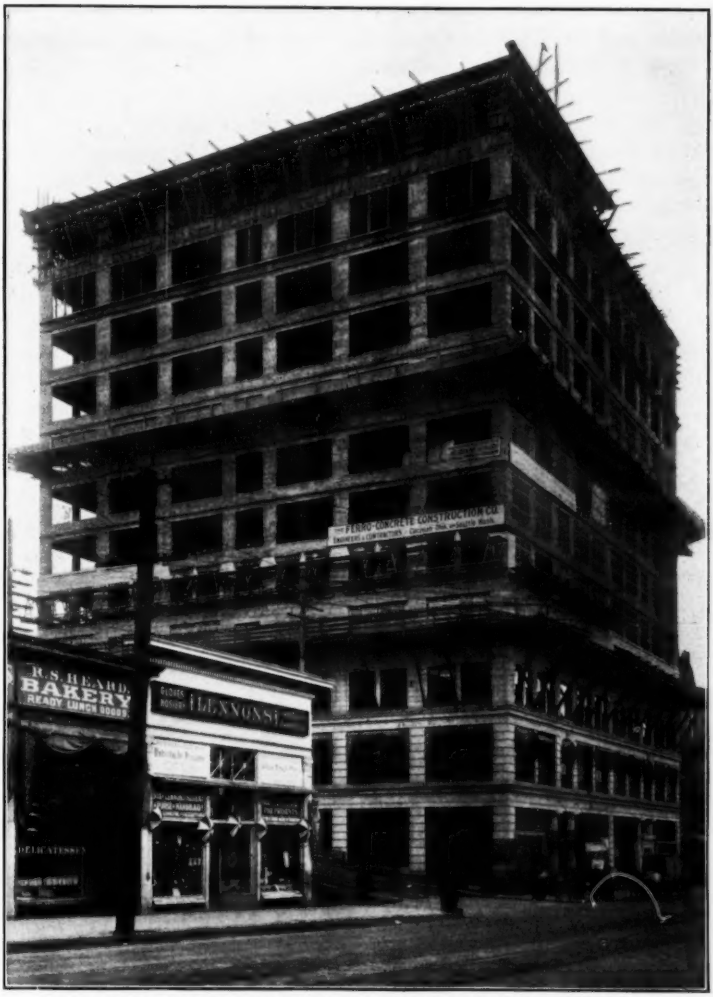
The ratio of height of column to its least diameter varies from 1/12 to 1/15. An additional rule should be added for building work, specifying that no concrete column shall be less than 12 inches in diameter, so that the pouring and ramming may be done in a satisfactory manner.

Great care should be observed in cleaning out from the column forms all loose pieces of wood, tile, or other rubbish, as these weaken the column and have contributed to cause failure.

There is a diversity of opinion regarding the stresses allowed in the vertical steel rods in concrete columns. It should be governed by the ratio of the modulus of elasticity of concrete to the modulus of elasticity of the steel. If the concrete is allowed 500 pounds per square inch and the ratio allowed is 1/12, then 6,000 pounds per square inch can be allowed safely upon the steel. The modulus of elasticity, or the stress, divided by the strain for concrete varies for different mixtures. In comparison, it varies from 1,800,000 to 2,500,000. For mild steel the modulus is 30,000,000. The differences in the ratios specified between steel and concrete in different codes arise in this way, as the ratio may vary from 1/12 to 1/17.

Stresses Allowed in Steel.

The stresses allowed in the reinforcing steel are much the same as for structural steel work, allowing 16,000 pounds per square inch for tension, and 10,000 pounds per square inch for shear. In some codes the stress is specified as 1/3 of the elastic limit, or as 1/4 of the ultimate strength. Under these last two rules high-carbon steel, with



REINFORCED-CONCRETE BUILDING OF THE EMPIRE AMERICAN BANK, SEATTLE.
The lower portion is occupied by tenants while the upper stories are still under construction.
Ferro-Concrete Construction Co.

high values for the elastic limit and ultimate strength, can be used to advantage. Twisting the steel has been shown by experimental tests to increase its strength from 30 per cent to 40 per cent, and twisted steel is used in some localities under stresses of 22,000 pounds per

square inch. The building codes should go more into detail on these points, and fix definitely the stresses allowable upon mild steel, high carbon, deformed and twisted bars.

Concrete Slabs.

The minimum thickness of slabs and the percentage of steel allowed should be specified by all codes. This has been done in very few cases, as the table shows.

REINFORCED-CONCRETE WAREHOUSE FOR EASTERN STATES REFRIGERATING CO., JERSEY CITY.

Kirkhan & Paulette, architects. Built by the Turner Construction Co.

Slabs should not be less than 3 1/2 inches thick, for below this thickness the resistance to shock becomes so little as to cause danger of holes being broken out of the slab by any considerable weight falling upon it. The depth of the slab should be governed by the span between the beams, and should not be thinner than 1/30 of the span. Beams and girders should have a depth of not less than 1/15 of the clear span.

The percentage of reinforcing steel in the slabs or beams should be limited. As many codes specify that the beam shall be equally balanced, so that the strength of the steel in tension shall determine the strength of the beam, the maximum percentage of steel allowed in the

beam should cause the beam to fail by pulling the steel reinforcement apart before the crushing limit of the concrete in the top part of the beam is reached. This condition will be realized if the percentage of steel in tension is kept at or below 1 per cent for 1—2—4 rock concrete.

Bending Moments.

The majority of codes specify that beams and girders shall be figured as being simply supported at their ends, no allowance being made for continuous action by top bars at the supports. This gives the bending moment for a uniform load equal to WL ÷ 8, where W = total weight supported, including the weight of the beam or girder, L = length of span in inches, the result being in inch-pounds.

For slabs, continuous action over the supports is allowed, limited to WL ÷ 10, and in some cases WL ÷ 12. When the slab is reinforced in both directions, so that its load is distributed on beams on all four sides of the floor panel, a bending moment equal to WL ÷ 20 is allowed.

Moment of Resistance.

The codes specify the following assumption on which the moment of resistance shall be based:

(a) The bond between the concrete and steel is sufficient to make the two materials act together as a homogeneous solid.

(b) The strain in any fibre is directly proportionate to the distance of that fibre from the neutral axis.

(c) The modulus of elasticity of the concrete remains constant within the limits of the working stresses.

(d) The dimensions of such a beam or girder and its reinforcement shall be determined and fixed in such a way that the strength of the metal in tension shall measure the strength of the beam or girder.

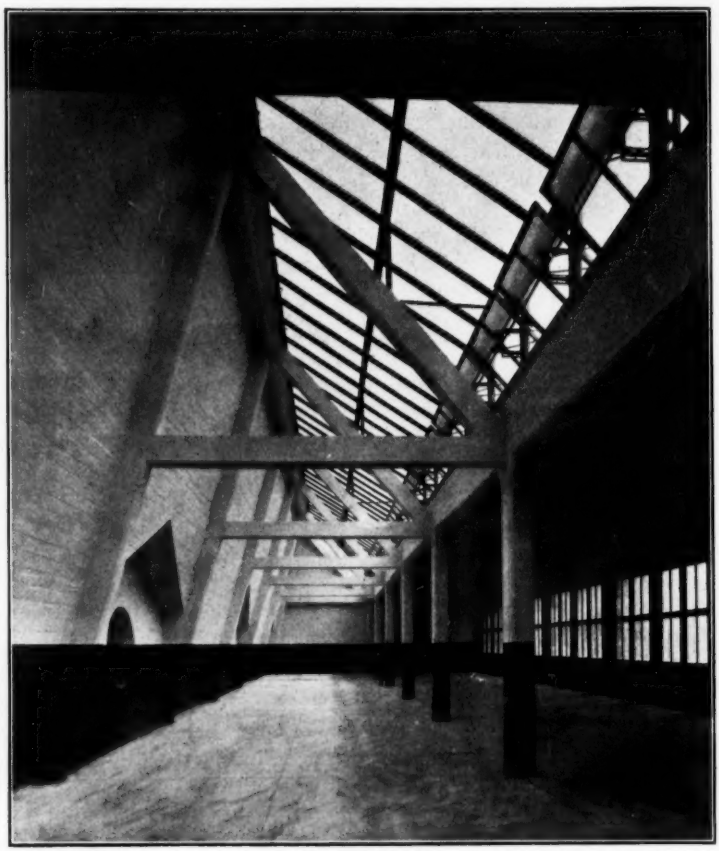
(e) If the concrete in compression, including the allowable concrete in adjoining floor construction, does not afford sufficient strength for the purpose, the compression side of the beam or girder in question shall be reinforced with metal.

(f) The tensile strength of the concrete shall not be considered.

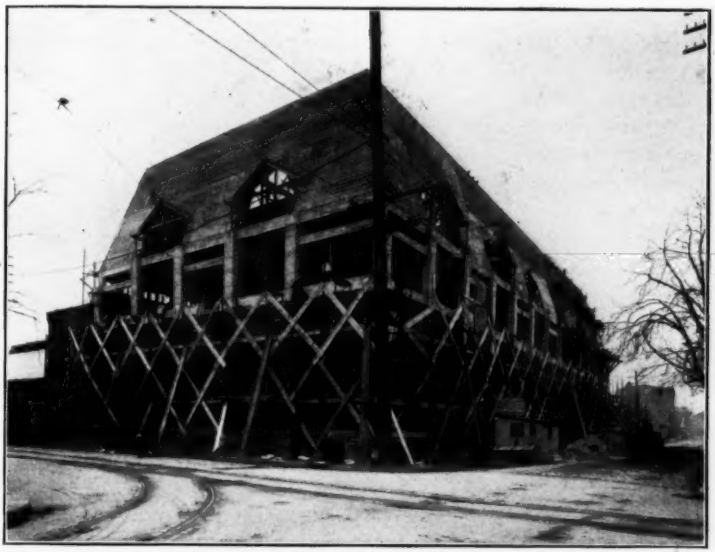
From these assumptions, the formulæ for determining the stresses in reinforced-concrete slabs, beams, girders, arches, and other parts are to be derived.

In order that the bond between the concrete and steel be sufficient to make the two materials act together, the steel should not be painted or covered with oil or any substance tending to keep the concrete from

adhering to the steel. The bond is improved by using deformed and twisted sections, and rigidly attached members reaching up into the concrete. All rust or mill scales must be removed from the steel before placing, as these will prevent proper adhesion of the concrete to the steel. The deformations of the bars must be of such a nature as not to impede the flow of concrete into them, and should have rounded edges, so that no sharp angles are formed in the concrete. This furnishes an additional reason for limiting the size of the broken stone used, as large pieces would allow hollow spaces to occur over



INTERIOR OF TOP FLOOR OF REINFORCED-CONCRETE BUILDING FOR THE MURPHY VARNISH CO.
Showing roof and skylight construction. Turner Construction Co.



THE MURPHY VARNISH COMPANY'S BUILDING, OF REINFORCED CONCRETE, NEWARK, N. J.

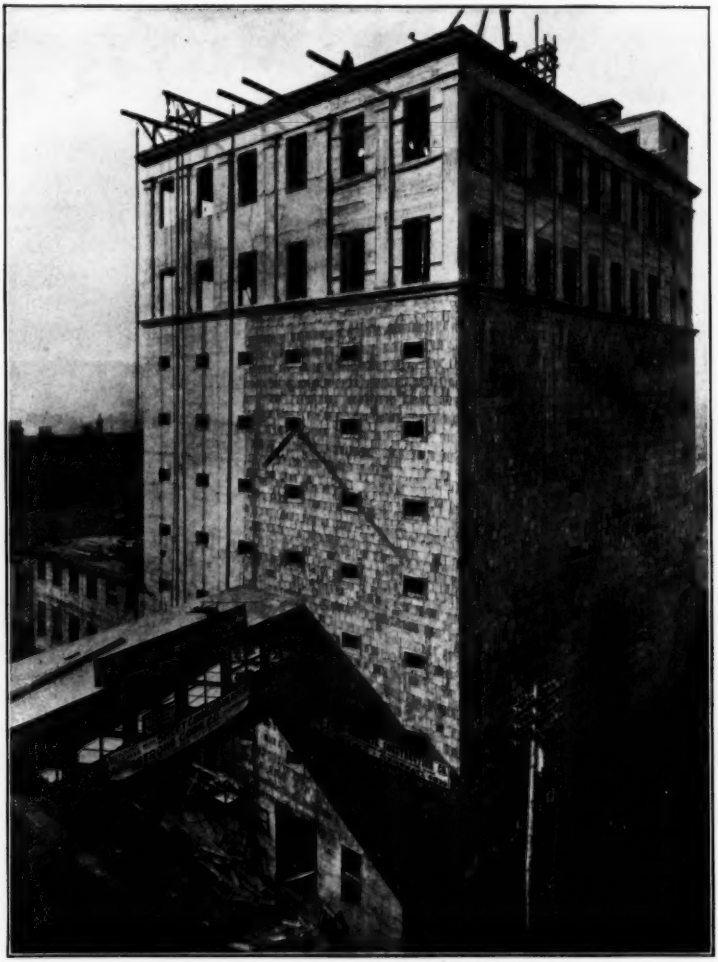
Howard Chapman, architect; built by the Turner Construction Co.

the cups and deformations of the steel, and form voids in the body of the concrete, thereby decreasing its strength.

The second assumption (b) is similar to the assumption made for computing steel and wooden beams. While it is not exactly true, owing to shearing stresses set up in the concrete and the action caused by the reinforcing metal, it is close enough for all practical purposes and simplifies the formulæ greatly. Within the stresses allowed with a factor of safety of four, it may be used with perfect safety.

The third assumption (c) is not quite true, when the beam is stressed up to its breaking load, as the curve of the stress divided by the strain is more nearly parabolic than straight; yet within the limits of stress specified by the codes it is on the safe side, and reduces the complication of formulæ.

The fourth assumption (d) is an excellent one, as the stresses in the steel do not vary to any great degree, and is a better measure of the strength of a beam than to figure the beam so that it breaks by compression of the concrete fir t. The value of the compression may vary, on account of the mixture not being quite uniform in character, and this rule obviates any excessive loading upon the concrete in compression.



COLD-STORAGE BUILDING OF REINFORCED CONCRETE, ROTH PACKING CO., CINCINNATI. Separate walls of reinforced concrete and of brick, with cork insulation. Plaster finish on exterior. Ferro-Concrete Construction Co.

The fifth assumption (e) is self-evident, and must be carefully determined when figuring beams. It is not economical to reinforce the concrete in compression, and it should not be done unless the limits fixed as to size of beam allowed require it.

The last assumption (f) has been widely discussed, and a variety

of opinions regarding the computation of the tensile resistance of concrete in structures have been expressed. Experiments have shown that fine cracks, barely visible to the eye, occur on the lower side of beams even before the load is applied. These cracks prevent the concrete from acting properly in tension, and for this reason the concrete should not be figured for tension stresses. If these cracks do not occur the factor of safety is increased, but the possibility of their occurring is sufficient to prohibit the use of tension stresses. These cracks do not interfere with the action of the steel, and they may be caused partly by the concrete shrinking slightly during the process of setting, the reinforcing steel holding the concrete so that the cracks due to contraction are small and occur at frequent intervals.

REINFORCED-CONCRETE BUILDING FOR THE HODGMAN RUBBER CO., TUCKAHOE, N. Y. W. L. Stoddart, architect. Built by the Concrete Steel & Tile Construction Co., on the Kahn system.

All the above assumptions, while not exactly accurate, err on the side of safety, and reduce the formulæ to simple terms.

CENTERING.

Very few codes specify the time of removal of centering further than to specify that the forms shall remain in place until the concrete has become strong enough to sustain itself. The rule should

be more definite, specifying, the minimum number of days for the different parts of the work. It is considered best to remove the column forms first, so that the columns may dry out better, but no load should be allowed to come upon them from the beams and girders for at least three weeks. The sides of the beam forms should be designed so that they can be removed, allowing the air to dry the beams. The careless removal of centering causes most of the accidents in concrete construction. A good system is to have all the centering posts placed on wedges, which can be taken out slowly, and the concrete work allowed to support itself for a day or so with the centering dropped a couple of inches below it, so that in case of settlement there will be no floor panels dropping upon those below and causing a general wreck of the building.

Concreting in freezing weather is prohibited by several codes, and should be by all, unless the work is protected properly from the action of frost. This can be done by covering the newly poured concrete with boards in such a manner as to leave at least 3 inches air space, then laying tar paper over these, and then a layer of sawdust, hay, straw, or manure. The under side of the concrete should at the same time be heated by the use of salamanders, and the sides of the building should be enclosed with canvas or other suitable material to keep the heat in. This must be continued until the concrete has hardened thoroughly, and all danger of freezing is past.

Frozen concrete is unsafe, and all portions which become frozen must be chopped out and replaced. The use of salt to lower the freezing point of the water may be adopted, but the salt must not be used in larger quantities than 1¼ pounds per bag of cement. If a good surface finish is desired, however, salt must not be used, as it produces surface efflorescence.

When for any reason the concreting has to be stopped, it must be done in places where the shear in the concrete is the least, as at the center of beams and slabs. Columns can be poured up to the bottom of the beams and then stopped until the beams and slabs are poured, which must be done at one operation.

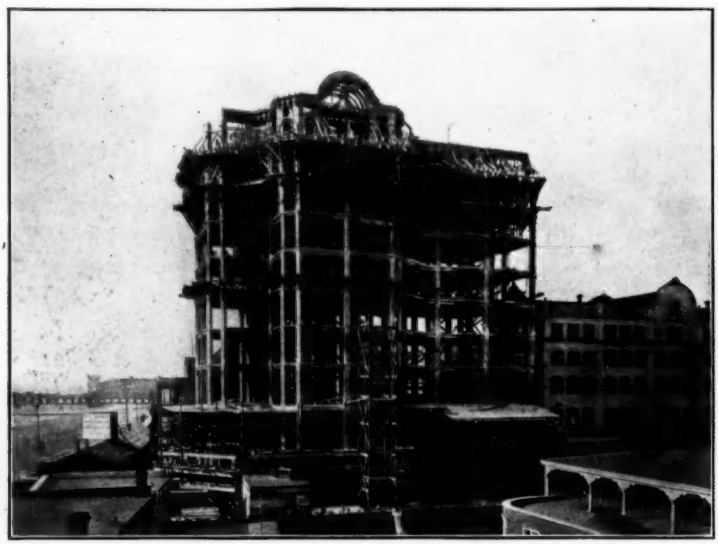
Walls.

There is a great diversity of rules concerning concrete walls. Some cities are very conservative, and do not allow any concrete wall to be built which is thinner than the brick-wall specifications. This is unfair to concrete construction, for a concrete wall has a greater bearing value per square inch than a brick wall, and is also one solid piece if poured at one operation, whereas brick walls are not. The concrete

THE INGALLS BUILDING, CINCINNATI; A TALL BUILDING IN REINFORCED CONCRETE, Elzner & Anderson, architects. The Ferro-Concrete Construction Co.

wall, when reinforced, has a capacity of resistance against outside pressure caused by wind, earth, water, or other substances pressing against it, which a brick wall never can have.

The codes should give concrete walls a greater value, allowing reduced thickness from the brick-wall specifications. This should apply, especially to walls for concrete skeleton construction. Some codes allow walls of reinforced concrete from 6 to 9 inches, depending upon the floor they enclose, while others allow nothing less than 12 inches to be used in skeleton construction.



THE NEW TRAYMORE HOTEL, ATLANTIC CITY, N. J.
Built of reinforced concrete on the Kahn system. Price & McLanahan, architects.

There seems to be a need of a national code of laws gotten up by experts, the rules for which shall be the result of careful study and exhaustive tests on all forms of concrete construction. The American Society of Civil Engineers has a committee which is now at work upon this question, and when its report is made, it will be of interest to all cities and those engaged in concrete construction. At present the codes do not cover the subject with direct printed rulings on all points in question, although the points not covered can be settled by recourse to the building inspector. A number of cities have no codes on reinforced concrete at all, and others report that they are preparing them.

A BAVARIAN MUSEUM OF INDUSTRIAL SAFETY DEVICES.

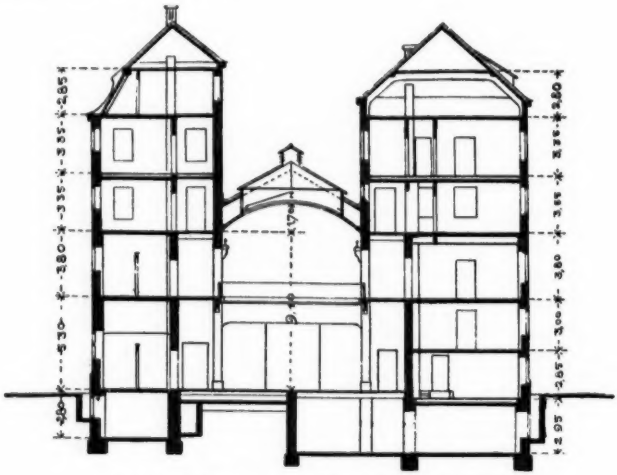
By Dr. Alfred Gradenwitz.

The United States and Great Britain are still far behind the Continental nations in safeguarding the lives and health of industrial workers but there are many encouraging signs of awakening interest. In the United States, the exposition of safety devices held last winter under the auspices of the American Institute of Social Science with its resultant plans for the foundation of a permanent "Museum of Security," in Great Britain, the work of the Royal Commission on Safety in Mines, and in both countries proposals for the enactment of laws for the protection of workmen evidence a public recognition of the need for better conditions, second only in importance to the vast amount of private work being done by large employers of labor. Dr. Gradenwitz's article describes one of the most important museums devoted to industrial hygiene in Germany where the cause of industrial betterment has been largely furthered by such institutions. It is noteworthy that the exhibits described fully bear out the contention in our editorial pages of a few months ago, that the educational value of such museums lies not only in "teaching the workman to value his own life," but also in impressing upon employers that the utmost precaution for safety and sanitary conditions in factories is the truest economy.—THE EDITORS.

TO protect workmen against the many dangers attending almost all branches of industrial occupation is a necessity, the importance of which is now fully appreciated, as evidenced by the good work done by modern social legislation. The tendency has appeared most markedly in Continental practice, and offers these precedents which may be of value for study and comparison under the more active interest now awakening in Britain and America. It therefore seems desirable to illustrate the results of some of these endeavours made to increase the safety of operation in factories and other industrial works by means of permanent exhibitions, foremost among which stands the Royal Bavarian Workmen's Museum at Munich.

This museum, which in its present shape was inaugurated at the end of last year, is intended to further any efforts made in the field of workmen's protection, while affording a comprehensive view of present achievements in the prevention of accidents, industrial hygiene, sanitary habitation and alimentation, and any other institution apt to raise the social level of workmen. The museum further demonstrates the use of safeguards for operatives using all sorts of machinery, and undertakes to examine the possibilities of such protective devices. Lectures on workmen's protection, industrial hy-

giene, and related topics further serve to popularise the subject, a thorough knowledge of which is made accessible by a special library connected with the museum.



GENERAL SECTIONAL ELEVATION OF THE MUSEUM.

The museum building was recently erected in the Pfarrstrasse, and occupies all the rooms of the ground and first floors in addition to part of the basement. The general arrangement and dimensions will be explained by the schematic views. From the vestibule a flight of stairs leads to an exhibition hall 27 metres in length and 6 metres in width, and to the engine room on the ground floor and to showroom in the basement. The first floor contains a similar exhibition hall of the same dimensions, and a gallery 2 metres in width surrounding the machinery hall, whence access can be had to the administration rooms, the officers' room, and the library and reading rooms.

The building is constructed of rammed concrete to the top of the basement walls, and brick masonry above that. All the ceilings, beams, columns, girders and roof framing are made of concrete-steel. The exhibition halls, galleries and administration rooms are lined with linoleum, while the greater part of the machinery hall is provided with a plank lining 7 centimetres in thickness secured to a set of anchored beams. The belting is arranged below the machinery hall, one-third of which is covered with double T-girders with simple T-rails screwed to the latter at average distances of 70 centimetres, removable planks 9 centimetres in thickness being fitted in the intervening spaces. These

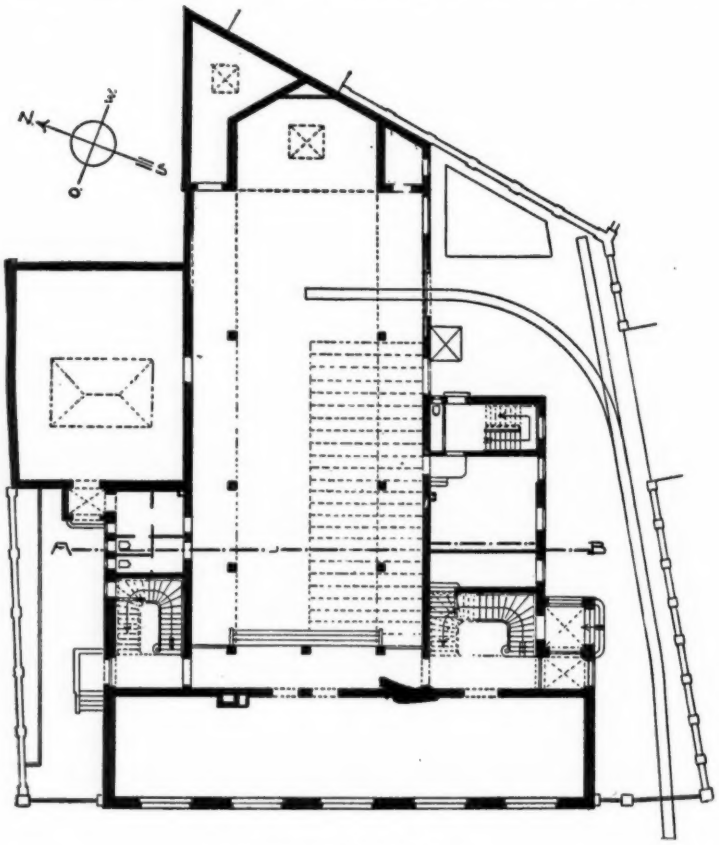
planks are replaced at will by all sorts of machines secured to supports of equal height, which are thus independent of any foundation.

In the asphalted courtyard there is a track leading from the street through a sliding gate to the centre of the machinery hall. Beside the sliding gate and close to this track there is a hand-operated elevator for the transport of boxes, etc., to the basement. The machinery hall is covered over with a Morier vault below the concrete-steel frame, the runway of the crane being secured to the abutments of the latter by means of concrete-steel brackets. The travelling crane of 3-tons capacity covers the hall between galleries and can be run the entire length of the hall. Ample illumination is provided by side windows of modern construction, in addition to three double sky-lights 7 metres in length and 4 metres in width, which are fitted with ventilation valves operated from the gallery. Snow-melting devices connected to the central heating plant are provided between the two glass surfaces 1 metre distant from each of these sky-lights. All the rooms of the building are connected to a central low-pressure heating plant fed from two boilers; the building is lighted by electricity throughout.

The many machines installed in the museum are driven from three lines of shafting, while a number of recent additions are operated on the individual electric system. All belts are protected by wooden boxes or perforated sheet-metal cases, while the electromotors, as well as their starters and cut-outs, are enclosed in ventilated glass cases, through which they can be inspected by visitors.

The department given up to the operation of steam boilers is especially interesting. This contains some strikingly deformed steam-boiler parts, calling to mind certain grave steam-boiler disasters and illustrating the factors liable to prove fatal to boilers, such as the use of defective material, deficient construction, want of water in the boiler, slow corrosion due to unsuitable feed water, boiler-scale deposits and the resulting superheating and bulging of the boiler sheets, action of the sulphurous acid contained in the combustion gases, corrosive action of the carbonic-acid bubbles evolved on heating the feed water, etc. Cracked water gauges illustrate the necessity of designing a safeguard against the water and steam blowing out and the glass débris flying about; the destructive effects of water shocks are illustrated by the cross-head of a destroyed steam engine. Water gauges with divers protective mantles are exhibited in a special room, which also contains signalling apparatus, giving an alarm to the engineer in charge of the boiler whenever the water level through

neglect in superintendence or irregularity in operation has fallen below a minimum. Valves which in the case of steam pipe fractures are closed automatically, thus preventing the issue of steam, as well



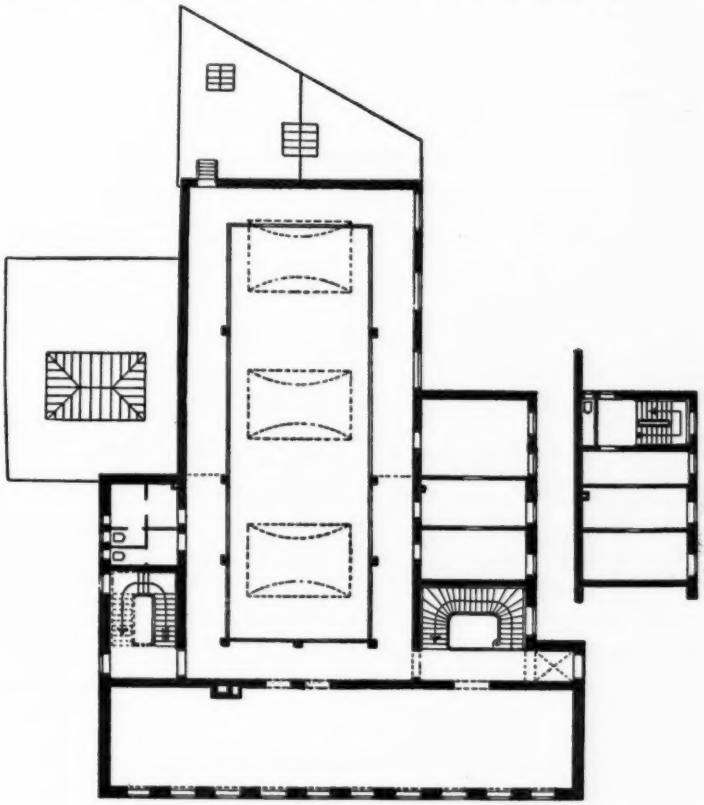
GROUND FLOOR OF THE MUSEUM.

The exhibition rooms occupy the T-shaped center. At the left is the auditorium. A small workshop is between the stairways on the right, and a drafting room in the acute angle at the top of the plan. The dotted lines across part of the exhibition gallery indicate the power transmission system below.

as a number of fixtures ensuring the safety of boiler operation, such as manometers, etc., are other exhibits of this interesting section.

The electrical department contains in the first place high-tension fuses, especially in connection with telephone plants. Those ex-

hibited by a Munich firm will protect such plants against lightning and high-tension currents, which are conveyed to the ground conductor through toothed plates. Protection against loose high-tension



UPPER FLOOR OF THE MUSEUM.

The exhibition space occupies the cross arm of the T and the galleries around the vertical stem. The three small rooms at the right of the main plan are the library, the officers' room and the business office. The detached section on the right is a plan of the mezzanine, containing a kitchen and two chambers.

conductors hanging down from the poles is afforded by two short-circuit and ground-circuit devices which can be substituted for the more expensive and less reliable catching nets. In one of the constructions exhibited, the short and ground circuit is effected by a three-armed angular lever, which on the rupture of a wire will catch

with a clamp connected with the ground conductor, while in another case, short-circuits are produced by a ring of copper wire. This apparatus is used in connection with the self-acting high-tension switch installed in the central station, a relay being disengaged on the rupture of a high-tension conductor, thus disconnecting the latter from the machine and cutting out any current from the latter.

EXHIBITION OF DEVICES FOR SAFEGUARD AGAINST ACCIDENTS.

The same firm exhibits diagrams showing some recent designs of transformer cabins, in which the high-tension and low-tension parts are each entirely self-contained, and are not accessible simultaneously, thus excluding any risk of mistake. Another interesting apparatus is an automatic lightning arrester comprising a rotary carbon rod and a solenoid actuated by the magnetising current produced by lightning, which, by turning the carbon rod round, will break the electric arc; after which (the magnetising current having disappeared) the whole apparatus returns to its initial position, thus being ready for dealing with another discharge. Other exhibits are rubber boots and gloves for persons engaged in high-tension work, insulating tools, etc. An interesting type of automatic fire alarm dependent on the expansion of metal springs under the influence of heat will likewise be found here. At a given temperature, which is adjusted at will, this expansion increases to such an extent as to cause an electric contact to be closed, working an alarm bell.

A special department is reserved for safeguards to be used in connection with acetylene, with a view to eliminating any risk of explosion in acetylene-gas plants.

An extensive group of exhibits includes safeguards for motors and shafting, intended either to allow the engine to be started without danger, or to prevent any access to moving machine parts, or finally to stop the machinery immediately at a critical moment, or to eliminate any risk of an unexpected starting. The first purpose is served by switching levers doing away with the necessity of pulling or barring the fly-wheel of the steam engine past the dead point of the crank. Many varieties of starting devices for explosion motors, intended to prevent any danger arising from a premature starting or igniting, are also shown. In the case of motors of up to 14 horse-power these devices take the shape of convenient hand-operated cranks which are thrown out of gear automatically as soon as the fly-wheel is in advance of the motion of the crank, or as soon as there is a recoil. Protection against projecting parts of shafting, which might result in danger to the men engaged in sewing belts or lubricating bearings, is afforded by smooth, round wood planking. Other devices do away with the necessity of putting belts by hand on revolving pulleys or throwing them off the latter. These devices enable the heaviest belts to be handled by mechanical means, the pulley carrying the belt being brought up to the one to which it is to be shifted, and the belt changed when both are in motion.

An apparatus exhibited by Mr. Cejka of Munich comprises a trip fitted to a steam-engine cylinder and connected to the steam valve. This is disengaged by electrical means, closing the admission valves, opening the exhaust valves and actuating a fly-wheel brake that stops the engine within about 4 seconds. This apparatus is combined with a device for preventing water shocks in steam cylinders, which is used with good results in nearly all of the large Munich breweries.

A Munich architect illustrates by means of a set of diagrams his mode of construction for isolating the foundations of heavy machines and engines, otherwise liable to transmit heavy vibrations to the ground and accordingly to cause nuisance to the neighbours.

A special department is set apart for apparatus, designed to obviate dangers of fire or explosion. This comprises all kinds of fireproofing (asbestos, etc.), several types of safety lamps, and the explosion-proof vessels of the Salzkottem factory, in which, all openings being covered with a fine wire mesh, the flame is prevented from flashing back to the interior of the vessel. In addition to the electric

EXHIBITS OF APPLIANCES FOR INDUSTRIAL HYGIENE.

fire alarm above described, an apparatus called autopyrophone, which is based on a similar principle, also serves the purpose of signalling the outbreak of a fire. Special features are automatic fire extinguishers, in which the bolt of a sprinkler (consisting of a readily melting bismuth alloy) is caused to melt by the increase of temperature, thus allowing the water to escape. The same section comprises all kinds of rescue devices, as well as a collection of apparatus intended for use as first aid in case of accidents. An apparatus designed by Prof. Stockmeier is intended for demonstrating the explosiveness of the dust of aluminium bronze under certain mechanical conditions. Artificial-respiration apparatus deserves especial interest because of the grave mining accidents that have occurred in recent years.

Another section contains safeguards for the mining and quarrying industry, both in extraction and in transportation and handling. The extraction of raw material is illustrated by several photographs of quarries and by models that show the working in stages of the basalt quarry of Messrs. Staud & Co. Other models illustrate the methods of electric blasting used in limestone and sandstone quarries, collieries, and slate quarries. An interesting model of a magazine for explosives is remarkable for its light roof framing and wooden walls, which can be partially hinged up so as to prevent any excessive resistance to

the high gas pressure arising in the case of explosions. Apparatus for thawing frozen dynamite cartridges, viz. double-walled sheet metal reservoirs containing tepid water between the walls, are likewise found in this section. The most recent progress in the manipulation of explosives is illustrated by a collection of "safety explosives," (e. g., carbonite, etc.), which do not ignite fire-damp. Another exhibit of interest is a safety belt and rope grip for use in climbing in the mountains and in working on high buildings, roofs, towers, etc., which, while in no way interfering with the movements of the person, protects the latter against any danger of falling. Safeguards for the transport of materials are illustrated by interesting models of self-acting inclined planes, one of which comprises an automatic barrier, intended for preventing the transporting vehicle from going beyond the top of the incline. The ascending truck automatically opens the barrier, which after its passage returns of its own accord to its position of rest, thus locking it. Another model is a truck automatically locking the passage by electrical means, as soon as the lower station (receiving station) has advised the upper station (transmitting station) that the empty trucks are ready for starting.

Safety devices for the handling of materials are represented by a

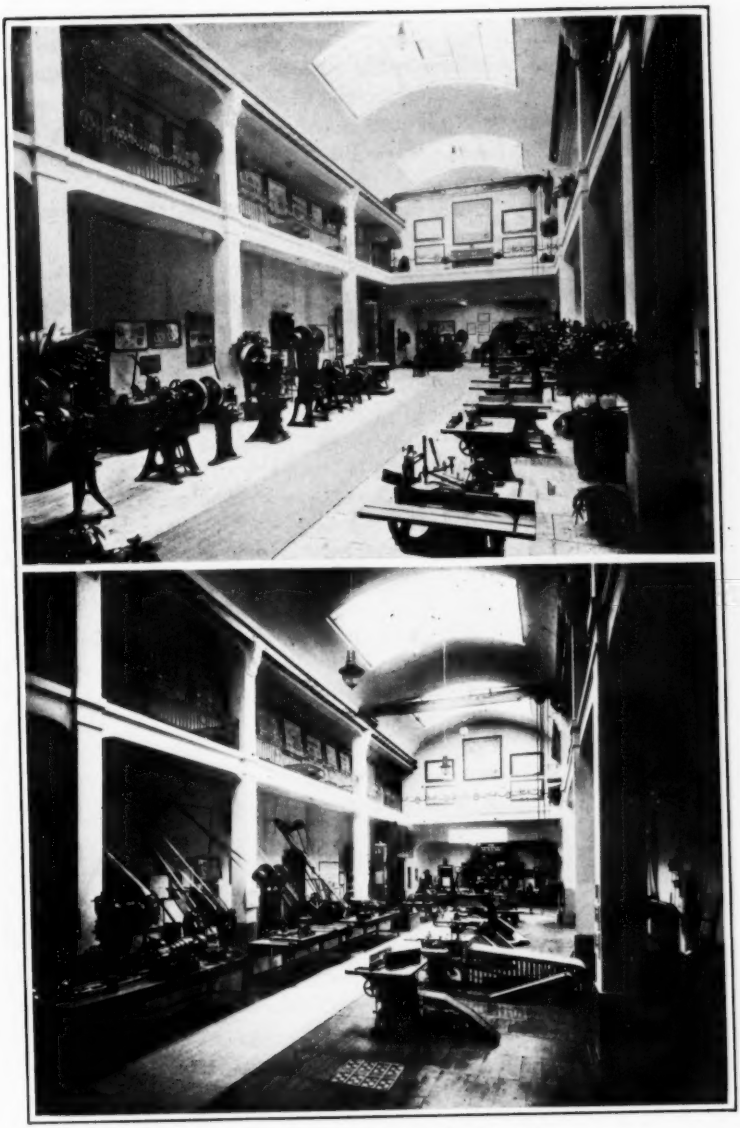
SAFETY METHODS AND APPLIANCES FOR BUILDING OPERATIONS.

model of a protective frame to be fitted over the mouth of clay-crushing machinery, as well as by diagrams illustrating the protection of mills, crushers, etc.

Of special interest among safety devices for metal-working machines are those pertaining to emery wheels; owing to their high speed of revolution and resultant risk of bursting, these are liable to cause the gravest accidents to operators. They are therefore fitted to the shafts by means of pressure discs and nuts with the intermediary of elastic plates, in addition to protective sleeves of various constructions. In the grinding of tools there is the risk of the tool being carried along between the grind stone and the support, thus jamming the hands. This risk is avoided by a movable grindstone support, which in such cases automatically recoils. Presses and punching machines likewise offer much danger in operation and especial interest attaches to the safeguards of such machines that are shown at the Munich Museum. In an eccentric press exhibited by Mr. Schuler, some protection against the descending ram is afforded by the very construction of the press, while an S-shaped protective grating prevents any involuntary approach of the hands within the dangerous range of the ram. In another eccentric press this protection is afforded by not allowing the machine to be thrown into gear before a protective grating has been placed in front of the piston.

In an adjoining room will be found stopping devices for punching levers and sheet-metal shears, protective linings for the projecting parts of chucks, safeguards for use in connection with lathe gearing, and an apparatus allowing machines fitted with claw clutches to be thrown out of gear nearly instantaneously at full load. Safeguards for the textile and related industries will be found in neighbouring rooms. Owing to the considerable dimensions of such machines, many of them had to be exhibited in the shape of models or diagrams. One of these models represents the lock of a beater, which can be opened only while the machine is stopped, thus precluding any injury arising from the beater. The Baudoin belt applier, viz. a vane loosely fitted on the transmission shaft for applying heavy belts to the rotating belt pulley, is likewise on view. The operation of weaving mills is represented only by shuttle guards of which many varieties will be found.

The leather and clothing industries are scarcely represented, one of the most remarkable exhibits coming under this heading being a punching machine constructed by Mr. Moenus of Frankfort a/M., which is provided with an automatically rising and dropping protective grating to guard against the approach of the matrix, and a



TWO VIEWS OF THE MACHINERY HALL.

centrifugal washing machine fitted with a safety lock and brake. A callender model most instructively shows how the hands, in introducing the cloth to be callendered into the rolls, can be guarded by an axle moving on two idlers near the mouth of the rollers and carrying a loose socket, which, though not applied directly to the cloth, owing to the motion of the idlers, partakes in the rotation but is stopped on any contact.

Another department is given up to safeguards for lifts and elevators, protecting the latter in the case of breakage of the carrying cables, or locking the lift pit, or finally, protecting the gearing. Safeguards of the first kind belong mainly to the catching device type, being based on the principle that on the parting of the carrying cable or belt a spring connecting with the lift is disengaged and drives the catching claws or wedges immediately into braking position. Another arrangement provides a suspension on both sides by means of a horizontal equilateral double lever, which in case of rupture or excessive tension to even one cable, is caused to rotate, throwing a catching device into gear. This lift also exhibits a double-leaf shaft-gate connected with the driving gear. Models of shaft-gates in the form of sliding doors which will open or lock the shaft opening gradually as the lift approaches or departs from the loading floor, are exhibited by several firms. In the case of express lifts, automatic reversals are liable to occur owing to the momentum of the cage; Prof. Ernst of Stuttgart therefore prefers a gear controlled by an operator, which would do away with any automatic adjustment at the various storeys. Safety cranks for capstans are likewise on show.

Another group of exhibits relates to wood-working machinery; these protective devices however are demonstrated mainly in the shape of photographs. Of special interest is a combined saw-milling and drilling machine with adjustable table, the stationary frame of which contains the cleaving wedge guide, in addition to which the machine is fitted with a protective hood for the circular saw and a protective cap for the milling of curved pieces. A number of protective hoods for circular saws are exhibited by leading German firms, and safeguards for milling machines are represented quite as fully.

Safeguards for use in the food-stuff industry are exhibited in a room adjoining the lift department. Mixing and kneading machines and meat-mixing machines are shown, in which all toothed wheel gearings are enclosed and the covers are bolted. Similar mixing machines, by the way, are used in place of crushing mills, in the manufacture of pasteboard. Dairy machines with all kinds of pro-

tective devices are further features of this department, as well as photographic illustrations of dough rollers, candy machines fitted with protective devices, and exhausters for snuff mills. An interesting exhibit is a safeguard against the explosion of mineral-water bottles, and a barrel tightener exhibited by a well-known Munich brewery.

Safeguards for agricultural machinery, such as steam threshers and fodder cutters, are likewise very fully represented, as are all kinds of apparatus for disinfecting the localities in which workmen are occupied.

The exhaustion of tar and acid vapours is illustrated by means of models, while several diagrams and photographs illustrate the great strides recently made in the illuminating-gas industry, from a hygienic point of view, especially retort-charging machines and coke extinguishers, which remove any fumes without nuisance to the neighbours and workmen. A number of articles forming part of the personal equipment of workmen, such as respirators, protective spectacles, smoke masks, asbestos clothing to guard against combustion by incandescent metals or hot gases, are further exhibits of the Museum.

A few rooms are set apart for sanitary habitation, illustrating by means of models, photographs, and diagrams, the housing of workmen. Much space has been devoted to sanitary buildings provided by the employer, while communal solutions of the housing problem are likewise fully represented. The ventilation, heating and lighting of workshops is illustrated by models and diagrams, exhausting plants being amongst the most interesting of this class of exhibits. Washing and bathing facilities designed for use by great numbers at a time are likewise very fully represented by diagrams and photographs. A related group of exhibits comprises all kinds of apparatus connected with the alimentation problem, such as meal heaters for factories, kitchen stoves, cooking boxes (fireless stoves). A number of institutions for the welfare of workmen, such as apprentice schools, are likewise illustrated in this department of the Museum.

Another department finally contains an extensive collection of models relating to the protection of workers in the building trades, such as safeguards for scaffolds, etc. Safeguards for use in connection with canal digging are represented by two instructive models in which the excavated soil is prevented from falling back into the pit, while passers-by are protected by a railing. Another model which will be found interesting is the Schaaf safety belt enabling the wearer to maintain a vertical suspended position while in no way interfering with his movements.

THE PROTECTION OF STEAM PIPES FROM ACCIDENT.

By Arthur Herschmann.

In the preface of Dr. Gradenwitz's article preceding we referred at length to the growing conviction that every possible safeguard should be thrown about the mechanical employments. Mr. Herschmann reviews briefly and comprehensively the results accomplished in protecting one particular engineering operation from the greatest risk to which it has been exposed. The short study is interesting for the ingenuity it discovers, and important because (as the author points out) the enormous extension in the use of steam power brings almost everyone within reach of the danger in question, and hence within the number of those immediately interested in the fuller introduction of the protective devices described. — THE EDITORS.

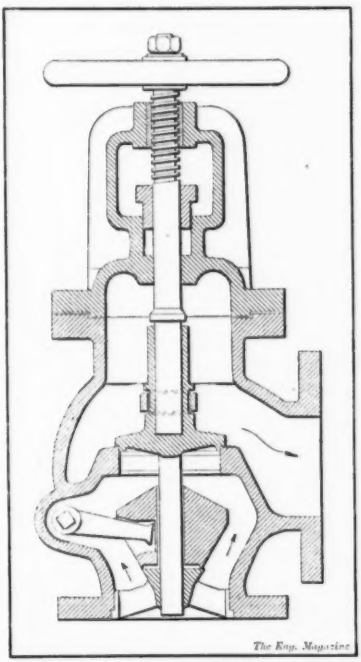
NORMAL activity tends to enlargement and improvement. Since Savery invented the atmospheric engine, to be followed by Watt's low pressure engine in 1768, the field of steam has expanded to so great an extent as to affect almost everybody in his daily work, directly or indirectly. The path of development of its use has been marked by improvements in the generation of steam and conversion into other forms of useful energy.

In the year 1801 Evans invented the high-pressure engine. The compound engine followed about 1850, the triple-expansion engine in 1880, and about 1890 the steam turbine became popularly known. Simultaneously, steam pressures have been constantly increased so as to obtain increased economy of coal consumption, and we find that today pressures of 150 pounds per square inch are in common use and that locomotive and marine boilers are operated at 250 to 300 pounds. The superheating of steam has also been known for a great many years as a means of obtaining increased economy.

Superheated steam of very high pressure became possible in sustained operation only with improved materials for the construction of boilers and engines and improved design of the latter. Manufacturing and testing have become standardized, and moreover systems of careful supervision have been evolved by highly organized boiler-inspection companies which contribute very largely to the high degree of comparative safety of which we may be proud.

The big boiler with its fire, the engine with moving parts and flywheel, are always in the public mind; less so the piping. Yet the latter, with its component parts such as fittings, presents a source of danger which is equally great in the aggregate.

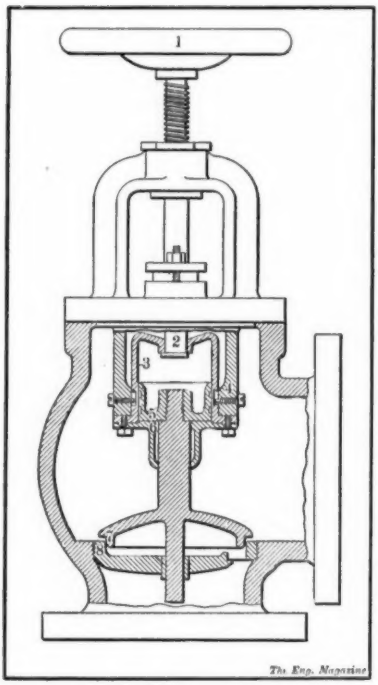
The danger of a failing steam pipe, or of other damage in the steam line permitting the sudden escape of steam, naturally is greatest with the highest pressure, as every pound of pressure represents increased capacity for devastation at the time of sudden release. The heat energy liberated to work damage is represented not only by the steam itself, but even more particularly by the heated water contained in the boiler which passes into sudden evaporation as soon as the pressure is suddenly taken off its surface. This water necessarily is at a temperature above 212 degrees, so that the surplus heat will be freed to generate more steam very quickly. The work of devastation will be helped by concussion, owing to water which is mechanically trapped by the steam when an explosion occurs and which enters the scene of accident very much like a projectile. The attendant shock is of course felt by the boiler, and if the seams of the latter are strong enough to resist it, chances are that it will be quickly bared of water and "burned out."



SECTIONAL VIEW OF THE H & M VALVE. Has no auxiliary pipes or pilot valves, and is not actuated by a piston. The valve is controlled by the flow of steam around the cone-shaped body, the upper valve closing when the steam pressure of its boiler falls lower than that of the other boilers with which it is connected. The upper valve revolves on its stem and cushions itself in seating and at the upper limit of travel. The position is indicated on the outside. H M Valve Co., New York.

But more important than the material damage which is likely to follow a pipe failure, is the danger to life.

Boiler rooms may still be found where the men must necessarily crawl through tight places to work a certain valve, or where a steep ladder must be climbed to reach certain fittings which might as well be worked from the firing floor. But in the best designed boiler room little opportunity exists to reach the exits safely should a large pipe



SECTIONAL VIEW OF THE LOCKE VALVE.

If a flue break or other accident occur, the valve closes, cutting the boiler out. Nor can it be cut in again until its pressure equals that in the main. The valve is held slightly above its seat as shown, the steam being shut off by the closely fitting extension; thus chattering is avoided and the seats preserved for hand closing. Locke Regulator Co., Salem, Mass.

burst and permit the boilers to empty their contents.

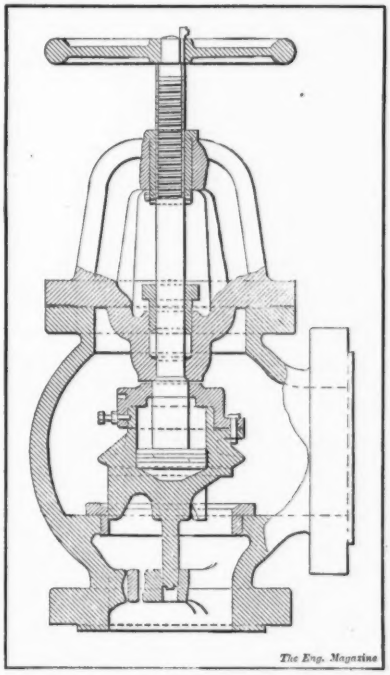
Let us assume that we are in a boiler room 60 feet long, 20 feet high, and 40 feet deep It is a 1,000 horse-power plant, four units, and we find that, after the boiler volumes have been deducted, a free air-space remains of 29,000 cubic feet. Let us suppose that only a supply line from the header bursts at a pressure of 150 pounds. The velocity of outflow expanded is 1,478 feet. (For comparison it may be noted that the muzzle velocity of a rifle ball is about 2,000 feet per second.) The discharge of steam for the 5-inch area is about 65,000 cubic feet per minute, so that in less than 30 seconds the room will be filled with suffocating steam. Think of the proportions of your boiler room, of those on board ship or in mines where pipe galleries exist, and make a comparison!

In view of this terrible danger many provisions are made to render pipes safe. The design of the piping is studied with the greatest care, so as to avoid initial strain. Special care is taken to provide for expansion, loops being frequently resorted to, and pitch is given so as to facilitate the flow of condensation. To minimize the possibility of rupture, piping of this class has even been strengthened by steel and copper wire winding. All these devices tend to reduce the chances of a pipe failure; but as experience proves that the failure can not be rendered an impossibility, means must be provided to check the rush of steam and isolate the defective line in case of the break of a pipe or fitting.

For the last fifty years valves have been on the market which could be operated mechanically from a distance, using levers, gears and chains, and more recently these devices have been designed to be actuated electrically. It is, however, plain that such a device will be a partial protection, at best. Serious accidents happen quickly and without the least warning; they leave no time to think and act, and must be averted automatically.

In the pipes of the average power plant steam travels at the rate of a mile per minute, or about that—say 90 feet per second for maximal average speed. Should a pipe break the velocity of outflow will be 900 feet per second, in round figures. Whereas pressure differences are but slowly transmitted, the above shows clearly that the great difference in velocity is effected at the moment of the explosion, so that the quickly traveling steam may be made to engage a valve disk in its path and "shut the door behind it." This sounds very simple, but in actual practice is most difficult of accomplishment.

A close study of the conditions of plant operation shows that such a valve must answer very conflicting requirements. Modern engines have high piston speeds; the point of cut-off may change very suddenly, and consequently if the safeguard valve were responsive to such a sudden rush of steam, it would close prematurely. This would seriously endanger a plant, and on board ship for instance would render a steamer unmanageable just at the criti-

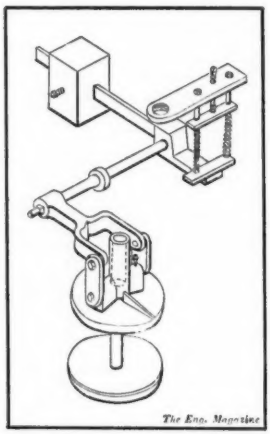


SECTIONAL VIEW OF THE COLDWELL-WILCOX VALVE.

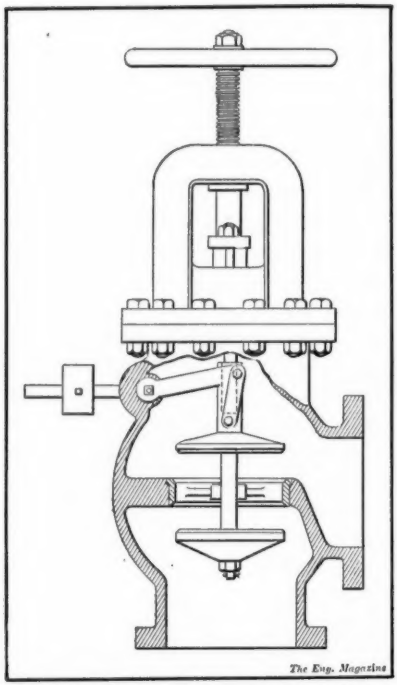
Any accident such as the blowing out of a tube or header, or anything causing a counter current through the valve, leads to its instant and automatic closing, preventing any passage of steam between the main header and the defective boiler or part. Coldwell-Wilcox Co., Newburgh, N. Y.

cal moment of manœuvering. On the other hand, however, it is necessary that even a comparatively slight pipe break should close the protective valve. To meet this conflicting condition such a valve must not be too heavy in its movement and I believe should be kept "off" the closing point by artificial means.

My experience seems to support the theory that gravity and the assisting ejector action of the flowing steam are reliable principles for a safe law of action which such devices shall obey and be made entirely dependable in practical plant operation.



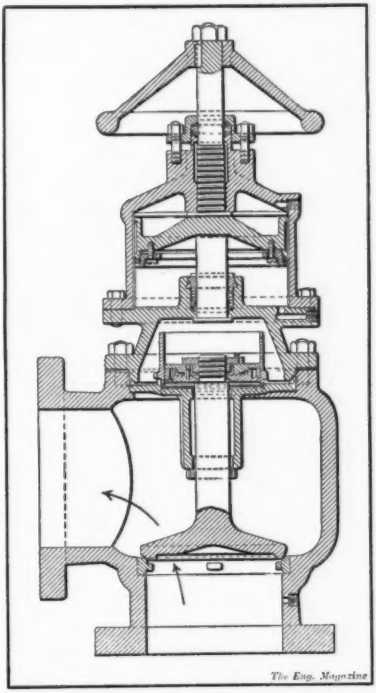
COUNTERBALANCE OF THE LAGONDA VALVE.



SECTIONAL VIEW OF THE LAGONDA VALVE. Works instantly either way, depending for its action not on differences of pressure but on the flow of the steam. No pistons or pilot valve and but few moving parts. The double-beat valve, closing upon either side of a double seat, is very nearly counterbalanced by the lever and weight; with a slight flow of steam it rises to mid position as shown, and so remains. A sudden rush caused by a break beyond will carry the lower valve up against its seat; a reverse rush caused by accident to the boiler will close down the upper valve. Either shuts off the boiler from the main. The weights of valve and counterpoise, the distance apart of the valve seats, and the strength of the springs are so adjusted as to prevent the valve from closing under ordinary fluctuations of normal working. The Lagonda Manufacturing Co., Springfield, Ohio.

It should be possible also to adjust such valves to suit the nature of the plant, and these adjustments should be rendered "fool-proof." The inter-

nal moving parts should be few, and so arranged that they cannot easily corrode, rust together, or tighten up. The safe action of the device must be independent of the degree of opening of main valve. If the main valve is combined with the automatic valve, then the closing spindle of the former should be made to "stir" the latter every time it is worked up and down. Once the valve has closed automatically, it must stay closed, otherwise it might re-open on a group of people who are likely to rush to the scene of accident. It may advantageously show its position from the outside. It should be double-acting—that is, protect both the boiler and the line. It must possess special strength to resist the shocks to which it may become exposed. These are but few of the most important requirements which such devices should meet to be desirable.

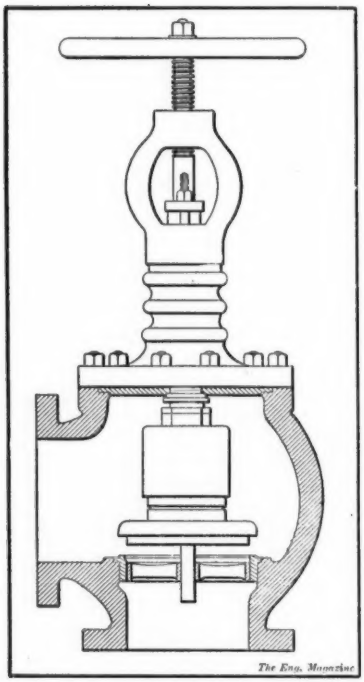


SECTIONAL VIEW OF THE FOSTER VALVE.

Worked by hand, either directly or from a distance, but will shut off automatically in case of any accident breaking pipes or connections. The main valve shown is operated by a pilot valve. Any sudden drop of pressure below a predetermined limit relieves the pressure in the chamber of this pilot, a spring immediately closing one valve and opening another, thus permitting the boiler steam to pass into the piston chamber of the combination valve. The piston, being of larger area than the large valve, will instantly close this latter against its seat and prevent passage of steam in either direction.
Foster Engineering Co., Newark, N. J.

The testing of such devices in the shop affords a means for their reliable adjustment but does not adequately represent their true value in case of emergency when the human mind might be so affected as to upset clear reasoning and quick manual operation.

In the United States this subject has in the last few years been given considerable attention and there are probably not many experienced engineers who do not recommend pipe protection. In France automatic valves have been compulsory since 1886 when the explosions of Eurville and Marnaval liberated steam



SECTIONAL VIEW OF THE NEW BEDFORD VALVE.

Raising the hand wheel lifts the cylinder attached to the stem, the disc remaining closed until the pressure in the boiler equals that in the main and closing again at once if the boiler pressure falls below that of the steam line. The action is noiseless and positive; if the pressure falls, from accident or other cause, the valve closes. New Bedford Boiler & Machine Co., New Bedford, Mass.

which killed 30 people and seriously injured 60 others. Marine boilers are not governed by this law. In other European countries such laws are now being considered, and in Norway a regulation exists governing the use of special shut-down valves on marine boilers and their piping.

Whether the installation of such safeguard devices proves demonstrably profitable or not, the investment represented by them should be made out of the profit and loss account and it should be considered in the same way as advertising, and insurance of other kind. Actually the insurance which they provide against interruptions of various kind may be expressed in dollars and cents.

That pipe protection saves life is no longer questioned by those in a position to know of the occurring pipe failures although these may not be reported in the daily press. To such persons it is a matter of surprise to notice that occasionally the question is still raised if it is not a safe gamble just "to depend on the piping." The tendency of the times is to be more and more exacting that every known precaution shall be taken to protect life and limb. Legislation may soon put these requirements into mandatory form; but purely economic (to say nothing of humanitarian) reasons impel the far-seeing manager or owner to be in advance of legislation in such matters as this.

PULVERIZED COAL AND ITS INDUSTRIAL APPLICATIONS.

By William D. Ennis.

I. THE CHARACTERISTICS AND PREPARATION OF THE FUEL.

In a preceding series of articles in this magazine, Professor Ennis discussed the advantages to be secured by burning in the boiler furnace the small sizes of anthracite—that is, those grades which include the very fine coal naturally produced at the breakers, but requiring special grate and draft arrangements to make their firing practically successful. In this article and a succeeding one he takes up an extension of this idea—that of artificially reducing the fuel (though in this case it is bituminous coal) to a still finer state and blowing it, mixed with air, into the furnace. The practice has already found advantageous application in the cement and other industries, and offers large hope for relief from the smoke problem through its introduction into power-plant and similar work. The present installment of the review covers the preparation of the fuel, and a following one will take up the actual firing and the devices for that purpose.—THE EDITORS.

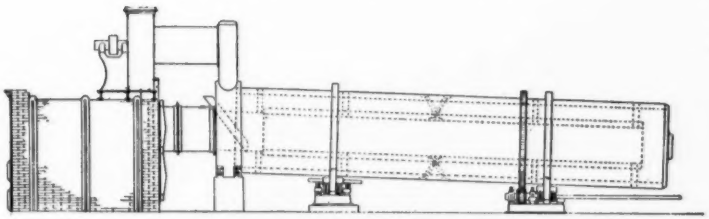
FINELY powdered coal has been used as a fuel in various industrial operations for many years. It is familiar to the foundryman as an essential constituent of many high-priced facings. As fuel, it has been quite widely employed in annealing and heating furnaces, and more generally in connection with rotary cement kilns. In the last named, the requirements for a hot fire and long flame, with ease of accessibility to the kiln for repairs, early led to the adoption of either oil or natural gas as the only fuels commercially possible. Where natural gas is generally obtainable nothing can compete with it; but under the ruling prices in the eastern and middle States, the use of fuel oil involves a cost of operation about double that obtainable with pulverized coal. The ash from this latter fuel affords no complication, entering into the cement "clinker" and thus eventually commanding a price of something like $10.00 per ton. It is stated that pulverized coal was used in rotary puddling furnaces in the arsenal at Woolwich as early as 1873. The bibliography of the subject leads back as far as 1831, to Henschel, and suggests the names of Wegener (1891), Unger, Friedeberg, De Camp, Ruhl, R. Schwartzkopff, M'Cauley (1881), Whelpley, Storer (1876), Westlake, Crampton (1873), Stephenson, and Bryan Donkin. The use of powdered coal in forges and furnaces of various kinds is now becoming general and rapidly increasing. For these applications, a high per-

centage of ash is not generally found to be detrimental, and the grinding is seldom finer than from 24 to 30 mesh. Wherever powdered coal thus displaces oil, the saving in fuel cost is about one half. In replacing coke or coal with powdered coal, savings must be looked for, if at all, in the reduced labor cost, higher efficiency and increased output. That these considerations, together with that of convenience, have led to a widespread use of fuel oil would seem to indicate that they are of considerable moment.

The application of pulverized coal to steam-boiler operation, although offering well realized advantages, has progressed until recently very slowly. The common view of the matter, that pulverizing is destined to solve the problem of utilization of the waste products of the mine, does not seem likely to be realized. That coal in a finely triturated condition permits of such perfect mixture with air as to furnish the conditions for ideal combustion is a far more vital phase of the subject. The most successful steps taken toward the utilization of mine dust and refuse have been in connection with briquetting processes, which, however, present no advantages over the combustion of ordinary coal with relation to control of air supply. Briquetting has been found to be most successful with bituminous or semi-bituminous coal. It appears to offer the only method yet suggested for the disposal of waste slack or of the refuse from the operations incidental to the marketing of anthracite. The coal is ground, mixed with heated pitch, and moulded to shape under a pressure of from ½ ton to 6 tons per square foot. The grinding need not be as fine as that necessary for pulverized coal. The briquettes may be made in a shape permitting of compact storage, but firing is always by hand. Over two hundred patents relating to briquetting processes have been issued in the United States.

Pulverized coal is physically interesting. A lighted candle can be plunged into it without other result than the extinguishing of the candle; but if the coal is sifted over a flame from above, in a thin stream, it flashes like gunpowder. A recent British report on bituminous dust describes microscopic examination as indicating that the individual particle resembles, not a solid, so much as a bubble of explosive gas. Each grain consists of hollow spores having gas within and about it. This dust contains from 25 to 67 per cent of ash, and from 18.75 to 30.54 per cent of volatile matter.

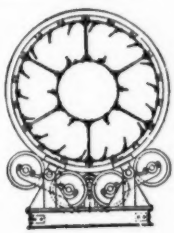
Under all circumstances, the storage and handling of soft coal is attended with some degree of fire hazard. This is particularly the case with low-grade coals, running high in volatile matter. When pulverized, these coals present a still more greatly increased hazard.



THE RUGGLES-COLES DRYER

Consists of two concentric shells of heavy steel plate, solidly connected in the centre by six heavy cast-iron arms, with swinging arms between the centre and the end to allow for expansion. The inner cylinder at the feed end extends through the stationary head and connects with the hot-air flue from the furnace. At the discharge end a revolving head fitted with lifting buckets raises the material and discharges it through the central casting. The cylinders are fitted with two heavy rolled steel tires ground true and revolving on chilled iron bearing wheels. The Ruggles-Coles Engineering Co., N. Y.

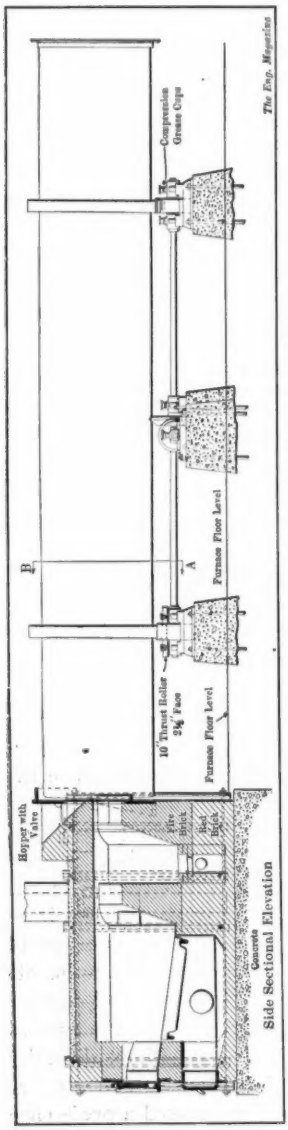
The processes of pulverizing and drying should be kept in a separate building, and the usual precautions taken against the possibility of dust explosions. Storage should be in non-combustible covered bins of small capacity, safely located and well ventilated. The danger at the burners is considered by the insurance authorities to be rather less than is the case with oil fuel. The pulverizing rooms must of course be well ventilated. No fires or lights must ever be permitted. In all cases of proposed installation, the plans should be fully worked out in advance and submitted to the criticism of the companies insuring the works.



CROSS SECTION OF RUGGLES-COLES DRYER.

The best coal for pulverizing is one containing upward of 30 per cent of volatile matter. Pulverizing processes, as exemplified in the United States at the present time, are not adapted to anthracite, or even to semi-bituminous coals. In this respect, pulverizing is strongly contrasted with the present state of producer-gas development, the one requiring highly volatile coal, the other a coal comparatively low in volatile. Anthracite dust might be burned if mixed with dust from gas coal; but it is not itself sufficiently gassy in its composition to maintain a flame in the furnace. Mr. S. H. Hall* reports experiments showing that coal containing less than 20 per cent of volatile matter would not ignite. A sample analyzing 35 per cent volatile ignited readily, and a somewhat less volatile coal ignited without difficulty when the combustion chamber was heated in advance. Among several works using pulverized coal for fuel, one expressed a preference

* Thesis, Sibley College, Cornell University, 1903.



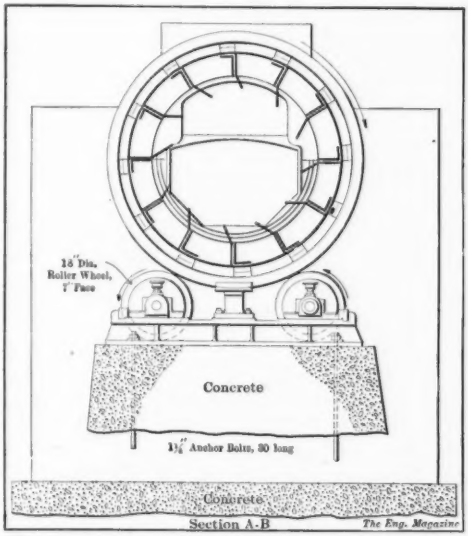
LONGITUDINAL SECTION OF A DIRECT-HEAT ROTARY-BLAST DRYER.

Direct-heat, direct-contact type. The wet material and the furnace gases enter the shell at the higher end; as the dryer shell revolves, the material is repeatedly caught by the interior shelves, raised almost to the highest point of rotation, and showered through the hot gases, until it is delivered, dry, at the lower end. For coal drying a special furnace is used, with an air chamber between combustion chamber and shell. The forced-draft blast pipe is branched to both ashpit and air chamber, and by regulating the air supplied to these two points, the temperature of the gases entering the shell can be closely controlled. American Process Co., New York.

for West Virginia slack, but was actually using a coal containing from 30 to 33 per cent of volatile, 5 to 58 per cent of fixed carbon, and 9 to 13 per cent of ash. Sulphur was permitted to run as high as 6 per cent (this was in cement kilns) and the heating value of the coal was from 13,200 to 14,000 B. T. U. This coal was considered too low in volatile for the best results. Another works, which has been using pulverized coal for steam production for nearly five years, reports an average composition of .82 per cent moisture (as fired), 35.13 per cent volatile, 54.70 per cent fixed carbon, 9.35 per cent ash, and .99 per cent sulphur. This coal yields 14,080 B. T. U. per pound. A series of tests made at Detroit, in steam-boiler operation, specifies the following percentages in the coal used (Westmoreland, Youghiogheny);—fixed carbon, 57.40; volatile, 34.47; ash, 7.50; moisture, .63. The sulphur was 1.74 per cent of the total. This coal tested 13,315 B. T. U.

Tests made in 1904 at the works of the Erie Malleable Iron Co., Erie, Penna., where pulverized coal has been successfully used for

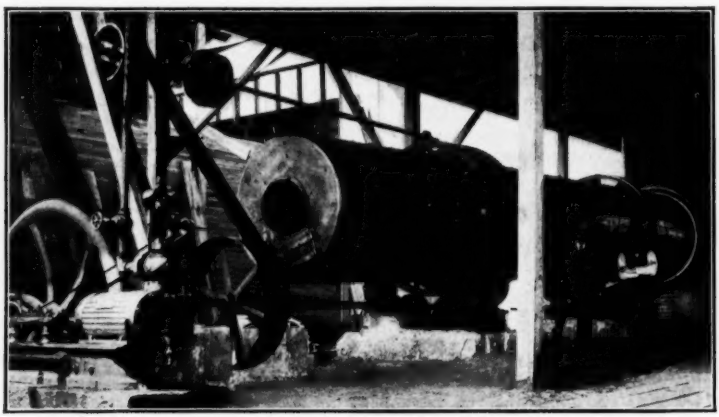
both heating furnaces and steam boilers during the past five years, gave the following composition for the fuel after pulverizing; fixed carbon, 53.7; volatile, 35.5; moisture, 2.4; ash, 8.4. The heating value per pound was 13,152 B. T. U. At Lebanon, Pennsylvania, the American Iron & Steel Manufacturing Company uses (for furnaces only) pulverized coal showing fixed carbon 58.49, volatile 31.97, moisture .52, ash 9.02, sulphur 1.34, heating value 13,721 B. T. U. Still another works shows 46.7 per cent of fixed carbon, 32.3 of volatile, 3.5 of moisture (too high for good results) and 17.5 of ash. The detrimental result of the high percentage of moisture is shown by the ash analysis, which was, 2.74 per cent volatile, 1.78 fixed carbon, 95.48 incombustible; a very poor result for pulverized coal. The main point to be observed from all these analyses is the evident effort toward a relatively high percentage of volatile matter. A long-flaming gas coal is what is needed.



CROSS SECTION OF THE AMERICAN PROCESS COMPANY'S DRYER.

Practice has also become somewhat standardized with regard to the grade of coal. In all of the examples quoted, the slack coal is used. This probably costs less to pulverize than nut or run of mine, at any equal stage of dryness. Unfortunately, the slack always contains more moisture than the other grades, and therefore always involves extra expense, either for drying, or for the greatly increased amount of power necessary to pulverize coal not thoroughly dried. It is therefore unsafe to accept too confidently the claim frequently made, that pulverizing offers a cheap and certain method for the economical utilization of mine waste. One of the works to which reference is made buys the 1¼ coal for furnace work, and uses the

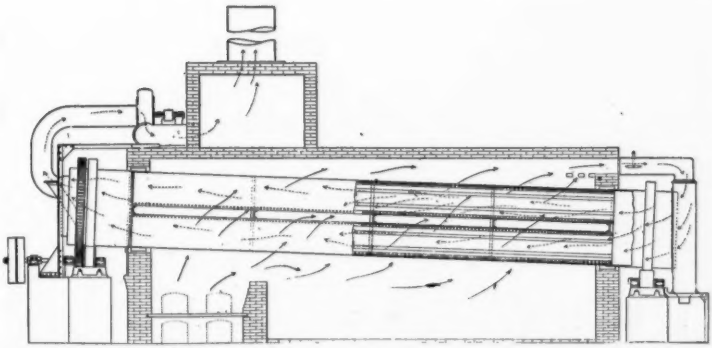
screenings for grinding. In winter, on account of the excessive moisture in slack, and insufficient dryer capacity, nut is purchased to augment the supply from its furnace screenings; yet this works does not aim to reduce the percentage of moisture below 2½. Mr. W. H. Bryan, in discussing pulverized coal,* states that the slack may be used, at a cost for grinding of 35 cents per ton, which cost will be offset by the saving in labor at the fire room. This would make powdered coal the cheapest of all fuels in St. Louis, at the ruling market prices. Mr. Bryan's premise that pulverized coal may be produced from slack or mine waste is correct; that it is universally made from slack at the present time, is scarcely to be claimed. That it can be produced at an expense that will be entirely offset by the labor saved does not seem yet to have been demonstrated.



AN INSTALLATION OF THE RUGGLES-COLES DIRECT-HEAT DRYER.

The process of pulverizing consists of (1) a preliminary grinding of the coal, if necessary, to bring it down to about nut size, (2) drying, (3) pulverizing proper. From the pulverizer, the coal is delivered to storage bins, and from thence fed to the furnaces by some suitable device which regulates the rate of feeding and in some cases the supply of air. The preliminary crushing referred to is unnecessary with some coals and with some forms of pulverizer. When necessary, the operation is performed by means of the ordinary type of roll crusher or cracker. The reduction of the large lumps thus effected facilitates the drying and permits of a proper regulation of the feeding of the coal to the pulverizer.

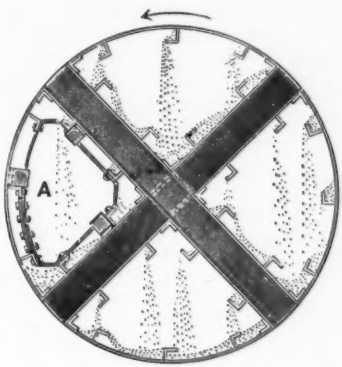
* American Machinist, July 12, 1906, p. 52.



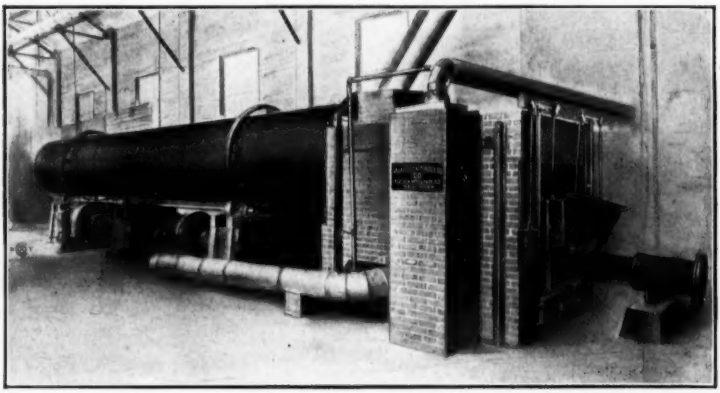
LONGITUDINAL SECTION OF FOUR-COMPARTMENT DRYER.
The C. O. Bartlett & Snow Co., Cleveland, Ohio.

The object of drying the coal is threefold: it prevents the material from forming pasty snowball-like masses, thus interfering with its conveying from stage to stage of the process; it permits of more perfect feed-regulation at the furnace; and it keeps the small particles separated, thus permitting of perfect air mixture and perfect combustion within the furnace. Moreover, the finely divided coal is much safer with respect to spontaneous combustion if thoroughly dry. The operation of drying is of course cheapened if the coal is first stored under cover sufficiently long to drive off part of the moisture, but this is rarely done. The cost of fuel for drying, with coal at $3.00 per ton, should never exceed 6 cents per ton, and coal is rarely re-handled at as low a cost as this.

Direct heat is practically the only drying method now practiced, steam dryers having long since been abandoned. With a material like coal, steam dryers would have certain advantages with regard to safety: but these are overweighed by other considerations, mainly those of capacity and economy. As ordinarily designed, coal dryers are externally fired cylinders, sometimes enclosed in brickwork, special precautions being taken to prevent contact of the coal with the flame. In certain cases, the



CROSS SECTION OF C. O. BARTLETT & SNOW DRYER.



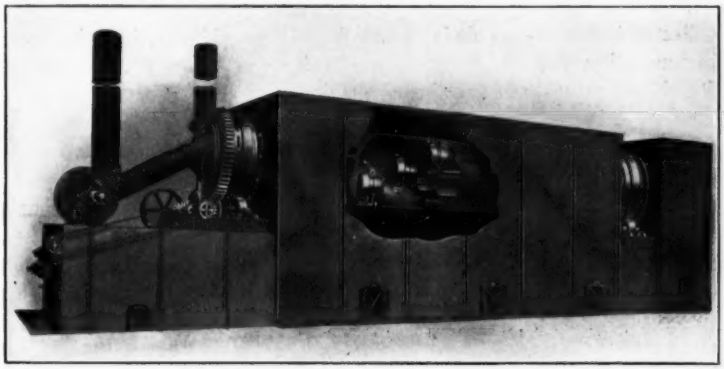
THE AMERICAN PROCESS COMPANY'S DIRECT-HEAT ROTARY DRYER INSTALLED.

hot gases, diluted with air, are permitted to reach the coal at fixed stages of the operation. The figures illustrate commercial forms of dryer largely used. In the one shown on page 469, after the heated air has been used for heating the outside of the cylinder, it is drawn through an opening in the arch over the cylinder at the rear end, through a steel flue into the rear-end breeching, and through the cylinder, coming in direct contact with the material, passing out through the exhaust fan and carrying the moisture with it. In drying material which will not permit of passing the furnace gases directly through, the air ducts in the brickwork are brought together at the rear end and connected to the rear breeching, and then drawn through the cylinder in contact with the material. The walls of the dryers are always built with air ducts. The four-compartment direct-heat rotary dryer of the type illustrated on page 469 has an air or gas space between each two compartments. This increases the heating surface, and the compartment arrangement of the cylinder divides the load so as to decrease the strain on the structure of the dryer cylinder. The Bartlett-Snow dryers are made in various sizes, the Number 6 having a capacity of 6 tons per hour, and the Number 10 of 10 tons; both drying from 10 or 12 per cent down, say, to 1 per cent. The former has a cylinder 48 inches by 27 feet, the latter, 60 inches by 28 feet. The horse power required to revolve the dryer and operate the fan is stated to be 5½ for the Number 6 machine and 8 for the Number 10.

The Cummer dryer, shown on page 471, avoids the compartment arrangement, passing the gases directly into the cylinder through

hooded openings as shown. A sufficient number of openings is put into each cylinder to allow about three-fourths of the entire volume of gases to pass into it. The balance of the gases enters the cylinder through the rear end. The result is that there is comparatively little circulation at the rear end of the cylinder where the material is practically dry and often dusty, and consequently there is little or no dust blown out at the stack.

The Schwartzkopff dryer, not illustrated, has four compartments, as in the one shown on page 469. All of these dryers feed the wet material in, continuously, at the front, or cooler end, of the cylinder, the hottest gases thus coming in contact with the dryest material. The American Process dryer, (pages 466-467) follows the reverse order.



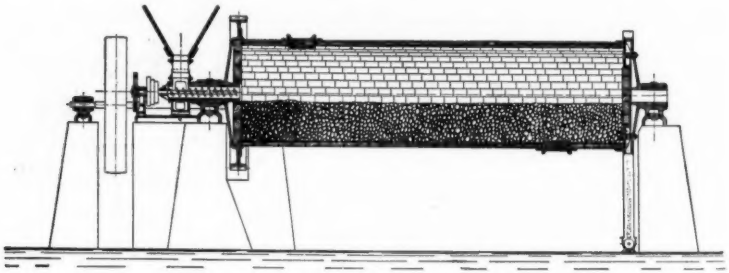
SELF-CONTAINED DRYER WITH EXHAUST FAN.
F. D. Cummer & Son Co., Cleveland, Ohio.

The fuel consumption for drying has been found by various users of pulverized coal to range from 1 to 1½ per cent of the weight of coal dried. Taking 10 per cent as the initial, and 1 per cent as the final, amount of moisture in the coal, each ton of 2,000 pounds would contain 200 — 20 = 180 pounds of water, to evaporate which requires 180 × 966 = 173,880 heat units. With coal containing 12,000 B. T. U., a fuel consumption of 1 per cent or 20 pounds, would indicate a dryer efficiency of 72 per cent: or a fuel consumption of 1½ per cent would evidence an efficiency of 48 per cent. These are reasonable figures. Occasionally the coal leaves the dryer in a more or less dry condition than is represented by 1 per cent of moisture. At one cement works a sample taken by me showed only .33 per cent. Another works, using pulverized coal under steam boilers, ran at about 2¼ per cent of moisture. This was admittedly bad practice, and was

due to insufficient dryer capacity. The fuel used in drying may be coal, pulverized coal, or coke. The last named is frequently used in order to decrease the labor necessary for firing the dryer, to avoid the possible accumulation of soot, and to avoid any danger from long flames.

With insufficient dryer capacity, the use of low-grade slack coal is often impracticable, especially in winter when the coal may be received dripping wet and is usually required for immediate use. One works, as previously stated, was found burning nut coal, mainly on account of a lack of dryer capacity. A successful installation involves, necessarily, long dryers of ample size.

The exhaust gases from the dryers carry away more or less dust, which, from considerations of safety, economy, and hygiene, must be collected and saved. This is usually done by providing a dust chamber in connection with the exhaust fan. Such a chamber may be arranged for either on top or at one side of the dryer.



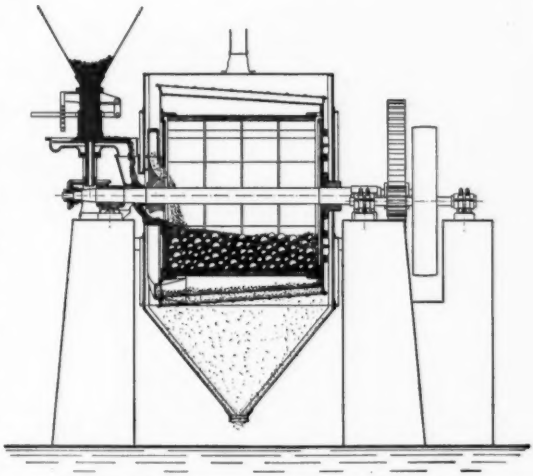
LONGITUDINAL SECTION OF DAVIDSEN TUBEMILL.

A pulverizer, not a coarse grinder. Made in three sizes—27½ by 9½, 33½ by 12½, and 35 by 13 ft., requiring 27, 80 and 120 horse power respectively. F. L. Smidth & Co., N. Y.

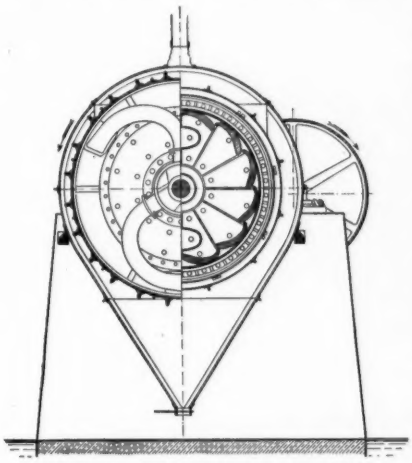
An important point in connection with drying concerns the volume of gases. If the gas moves in small volume and consequently at low velocity, it may at its initial high temperatures absorb and retain large proportions of moisture without exceeding a humidity limit of 70 to 80 per cent; but as it cools it may actually reach the dew point and deposit moisture on the material at the later stages of the operation. Large volumes of gas (excess air from combustion) and short lengths for transit are the remedies for this difficulty.

The operation of pulverizing is the present stumbling block in the way of standardized practice with regard to the application of powdered coal. Pulverizers give more or less trouble, the cost of operation is high, especially for power and repairs, and the pulverizers

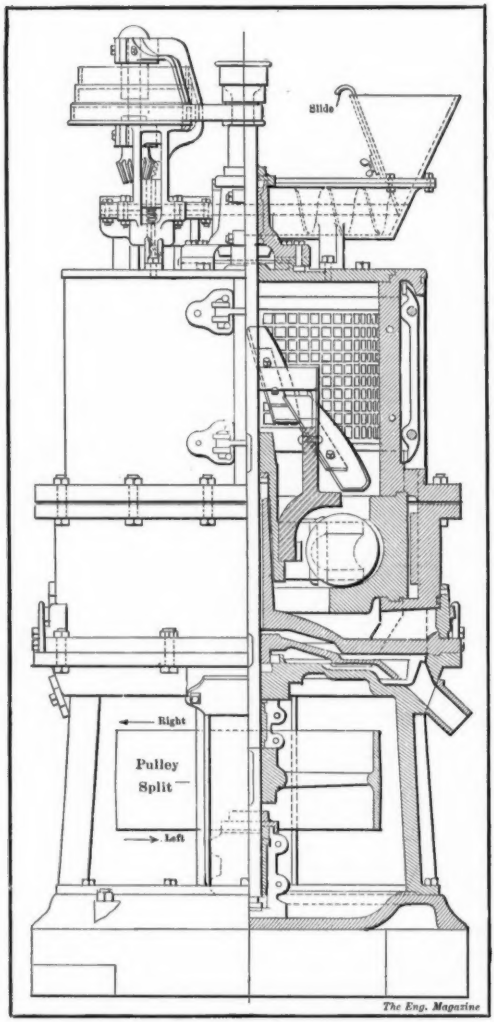
themselves expensive. Originally, the grinding of materials was done by means of burrstones or stamp mills; the former being used for soft substances, the latter for hard. At present, these forms of machinery are not employed for coal, which is extremely hard and slippery, and requires very fine grinding. The power consumed, and the capacity of the grinder, both depend upon the material, its nature, size, and hardness, the mesh desired, the uniformity of grinding necessary, and the percentage of moisture in the material. Pulverizers or grinding mills may be divided into several well-defined classes. One of the best known is the tube mill, a strong cylinder revolving on an horizontal axis, containing a quantity of flint pebbles, from 1¼ inch to 3 inches in size. The coal is fed in at one end, hammered by the pebbles, and taken out fine at the other end. This form of mill requires very little repairs, and probably grinds finer than any other. I have taken samples of the pulverized product from which only 1.96 per cent



LONGITUDINAL SECTION OF LINDHARD "KOMINUTER."
A low-speed coarse grinder, combining good qualities of ball mill and tube mill. F. L. Smidth & Co., N. Y.



TRANSVERSE SECTION OF THE LINDHARD "KOMINUTER."



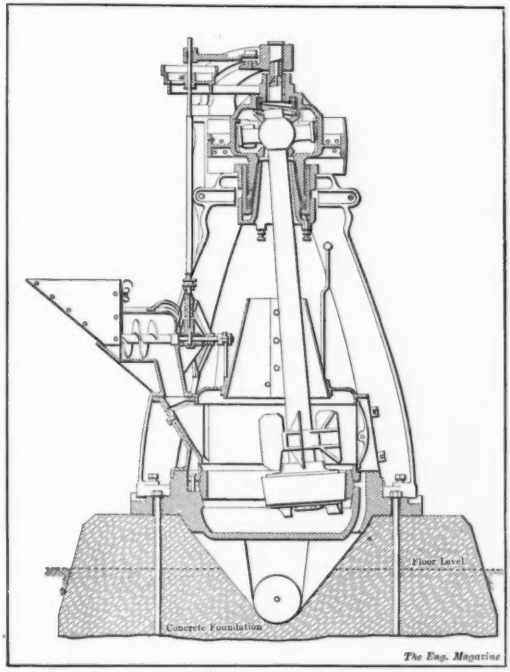
ELEVATION AND HALF SECTION OF THE FULLER-LEHIGH PULVERIZER MILL.

Lehigh Car, Wheel and Axle Works, Catasaqua, Pa.

was left on a 100-mesh screen, and only 3.22 per cent on a 200-mesh screen. The great drawback of the tube mill is the power required. One mill, 60 inches by 17 feet, running at 23½ revolutions per minute, used nearly 60 horse power. Another, 60 inches by 20 feet used 65 horse power on coal, and rather more on cement slurry, running up to 74 horse power on clinker. A 54 inch by 16 foot tube mill consumed 42 to 47 horse power. The power consumption can be greatly reduced by using special heads to permit of filling the cylinder up nearly to the top with coal and pebbles and thus balancing the load. In one case, this arrangement was claimed to have doubled the output while saving 40 per cent of the power.

Centrifugal roller and ring mills, with screen separation, are made by the Raymond Brothers Impact Pulverizer Co., the Schwartzkopff

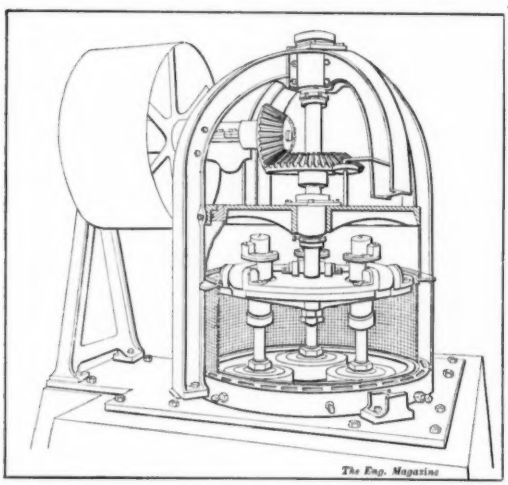
Coal-Dust Firing Syndicate, the Kent Mill Co., and the Bradley Pulverizer Co. Typical mills of this type are shown. One, the Griffin, has a single roll only. Others have two, three and four rolls. The capacity is given at 2 tons per hour with a power consumption of 20 to 25 horse power. A three-roller mill of the same make is stated to turn out 4 to 6 tons per hour with 35 horse power. A test run made at one works showed these mills, with the auxiliary dryer, but without conveying or feeding apparatus, to consume 84 horse power for a capacity of 5 tons per hour. This is equivalent to 4.2 per cent of the output in equivalent horse power. The repairs in this particular instance were about $20 per month on each mill. The Clark pulverizer, shown on page 476, is a three-roller mill adopted by the Schwartzkopff syndicate. The Raymond mill has four rollers, and is claimed to give 4 to 5 tons per hour from slack coal, with 60 to 65 horse power, when grinding 95 per cent to 100-mesh. It can be adjusted for almost any degree of fineness. The three-roll Kent mill (page 477) has powerful springs pushing the rolls against the ring. The ring and three rolls are the only wearing parts inside the housing, and a life of 3,000 hours is claimed for these. This mill has a claimed capacity of 7 tons per hour to 40 mesh at 20 to 25 horse power. One user reported capacities ranging from 1 ton at 80 mesh to 7 tons at 24



VERTICAL SECTION OF THE GRIFFIN MILL.
The Bradley Pulverizer Co., Boston, Mass.

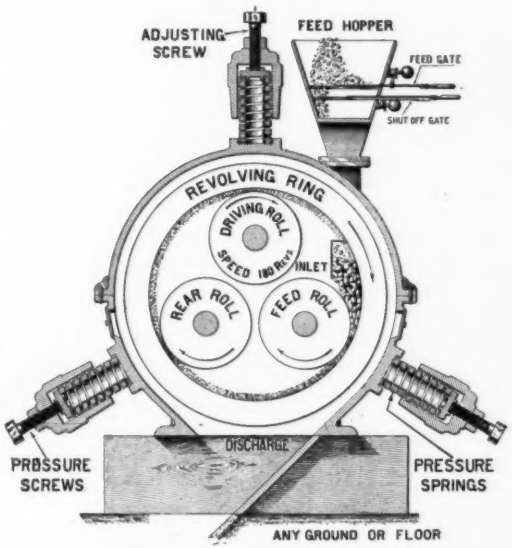
mesh, but the fineness determinations do not seem to have been reliable, as a sample claimed to be Number 30 was found upon examination to be 50 per cent Number 100 and 32 per cent Number 200. One set of rolls was stated to have run 5 years, 10 hours each working day. All these mills fracture the coal rather than cutting or rubbing it. All require external screen separation, with return of the consequent coarse particles for regrinding. The statements as to power consumption are apt to mislead, especially in the absence of data as to the uniformity of fineness.

Another type of mill, largely used, has hardened balls revolving in cast metal races at high speed. The Fuller-Lehigh (page 474) is an example. It has a claimed capacity of 3½ to 4 tons per hour, 95 per cent 100-mesh, at 32 to 35 horse power. The repairs in one case averaged less than $12 per month. An actual test gave an output of 9,810 pounds, 87½ per cent 100-mesh, per hour. Actual operation at another works gave an output of 5,000 pounds per hour at 30 to 40 horse power. This mill is largely used in cement works, and grinds fine. The Stroud mill is radically different from the others, depending for its effect on a cutting or shredding action. This mill will take coal in sizes up to 2½ inch, and will handle coal containing as high as 10 or 12 per cent of moisture, although at greatly reduced capacity and efficiency. It is stated to produce from 7½ to 12½ tons per hour. Like the Fuller-Lehigh and the roller and ring mills already described, it requires external screen separation, but the same manufacturers also build an air-separation mill, which is the type recommended by them where fineness is necessary, as in the case of coal. The air separation mill, as shown on



SECTIONAL VIEW OF CLARK PULVERIZER.
Schwartzkopff Coal-Dust Firing Syndicate.

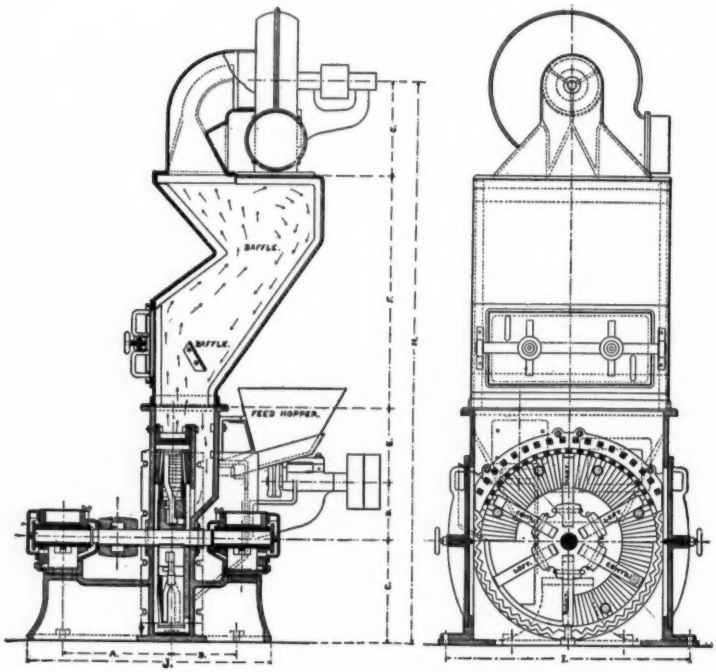
page 478, has a settling chamber from which the finest particles only are drawn off. It is stated to produce 4 to 5 tons of dust per hour at an expenditure of 40 to 45 horse power. The degree of fineness can of course be perfectly regulated by the speed of the exhaust fan. A fineness of 90 to 95 per cent 100-mesh is claimed.



SECTIONAL VIEW OF THE KENT MILL.
Kent Mill Co., N. Y.

The economical limit of fineness is reached when the cost of finer grinding equals the saving by increased efficiency in the furnace. The finer the better, disregarding this cost. Some consumers state 40 mesh to be sufficiently fine, but 60 to 80 mesh is more commonly used in steam-boiler practice. Much of the uncertainty as to power consumption and capacity of the various mills would be avoided if accurate data were obtained as to fineness and uniformity of fineness. The cost of grinding increases greatly as the fineness, or the uniformity, is increased. An outside figure for power consumption, sufficiently safe for preliminary calculations, is 1 horse power for 100 pounds of coal per hour. This may be decreased 50 per cent or even more, in practice. Coal is hard to grind.

The handling of the powdered coal is usually done by screw conveyors and ordinary belt and bucket or chain and bucket elevators. Leaks in elevator housings and in conveyor troughs are dangerous. It is not safe to store the coal in large quantities or for long times, so that small isolated storage bins should be used, and these emptied or the contents rehandled at regular intervals. The loss of weight in storage is not as high as with ordinary coal, but the loss of heating value is greater. Bins must have steeply sloping bottoms, the angle



SIDE AND END SECTIONAL VIEWS OF STROUD AIR-SEPARATION MILL.

which the surface of the coal makes with the vertical being only from 34 to 38 degrees, when dry. Wetter coal lies at a wider angle. The specific gravity of the coal is from 1.3 to 1.35. The conveyors to the feeding bins over the boilers should have end overflows, discharging into return conveyors, in order to avoid packing and breakdowns in case of the shutting off of the downtakes to the hoppers. On account of the problems involved in safe storage, it is preferable to have drying and pulverizing apparatus in duplicate units so that the coal may be ground as nearly as possible just as it is wanted for consumption. The same condition prohibits any widespread marketing of powdered coal by shipment from central points of preparation, an otherwise desirable arrangement.

THE FILING OF CORRESPONDENCE IN A MANUFACTURING BUSINESS.

By Sterling H. Bunnell.

THE ENGINEERING MAGAZINE was foremost in the recognition of the new profession of "Industrial Engineering"—that is, of the peculiar field for technical specialists afforded by the development and refinement of systematic, organized manufacturing. While this lies largely within the domain of mechanical practice, it includes in addition much that is drawn from economics and much that is taken from commercial principles. But in turn, the genius of the engineer has remodelled economic and commercial methods by scientific study and adaptation, and given them back to the business world better than he received them. Mr. Bunnell's article is concerned with one of these collateral elements in the conduct of modern scientific manufacturing—one which at first sight appears to belong to the office rather than the shop, but which, as he shows, is so intimately bound up with the successful prosecution of the business as a whole that it deserves the serious attention of the works manager. —THE EDITORS.

THE old system of filing letters alphabetically according to their writers, and making copies of all replies in consecutive order by dates in tissue copying books, has long since been found inadequate to the needs of modern offices. The single advantage of that form of filing is the certainty of preserving a copy of every letter written, provided only that the invariable rule of copying before mailing has been observed; for even faulty indexing cannot do more than delay the search for a certain letter. Against the loss or misplacement of letters received, the system affords no protection except by care in filing and consulting files. This being so, it is a question whether there is any real advantage in effecting greater security against loss of letters written than against loss of letters received; while the massing of correspondence from several firms which happen to have names commencing with the same combination of letters is extremely objectionable.

The modern system of filing letters vertically has practically taken the place of former methods. The vertical file has the advantage of convenience in use, first, because its divisions are merely paper folders which can be inserted in or removed from the file with all their contents, when desired, and second, because it is much more convenient to handle and inspect letters filed on edge in such a way that the sheets can be separated like the pages of a book and easily examined without removal. The vertical file is universally used to receive all corre-

spondence both into and out of the office. Carbon or tissue copies of each letter written are filed consecutively according to dates, with the letters received, one folder being given exclusively to the letters from and to each correspondent. By making the various forms used in the conduct of the business, shipping lists, specifications, contracts, and the like, on sheets the size of the usual letter sheet, it is possible to have but a single index for the entire correspondence.

The indexing of the vertical file is carried on in one or both of two ways. The alphabetical system is continued from the old form of filing, and for many purposes is most convenient. For very extensive correspondence, the numerical system is preferred, the name of each correspondent and the number assigned to his file being indexed on cards for ready reference. All letters received are opened by a clerk regularly designated, and each is given the proper number of the correspondence, nearly all of which are readily supplied from memory by the clerk accustomed to the work, while a few require looking up or entering as new names appear. In dictating replies, the writer gives first the correspondent's number, and no further attention is necessary, as the file clerk has only to follow the number in putting each sheet in its proper place.

In applying a filing system to a large manufacturing business modifications in details become desirable. Most of the correspondence, particularly the most important from a business point of view, originates by letters or other notifications giving knowledge of possible sales for the product of the concern. A correspondence is thereupon opened which may or may not amount to anything. Such correspondence is best placed in a separate file belonging to the sales department, and in general is most easily filed alphabetically, a new folder with tab pasted on carrying the name for indexing purposes. Letters and replies may accumulate to a considerable extent, but eventually the inquiry either comes to nothing, in which case the papers may be transferred to a case with other lost causes, or the correspondence develops into a sale, often followed by the signature of a contract. The entire file of letters is now transferred to the proper persons for investigation and decision upon the credit of the customer and the general acceptability of the order which the salesman has secured. The correspondence next goes to the construction department, and being given a number, is placed in the general file. It should be noted that all files in the office belong to the general scheme, except that for convenience certain sections dealing with inquiries are given to the sales department, others to the purchasing agent, and so on as found

most convenient. In planning the arrangement, it is necessary only to take care that letters from one correspondent on two entirely different topics shall not be so separated and filed that the entire information wanted cannot be secured by searching in one place. This is easily accomplished by a system of cross-reference, a sheet being placed in the general file whenever letters on different topics from one correspondent are for convenience placed in different sections of the file.

The construction department's general file becomes very bulky as time goes on, particularly so if the business involves work running over a term of months, or years. Having first copied the signed contract and other valuable papers and returned them to the fire-proof vault, the engineering department proceeds to make drawings, and corresponds with the purchasers from time to time with regard to the various features of the work and the questions that arise. When finally the articles are shipped, packing lists and other files are made out, and copies placed in the file with the papers belonging to the transaction. Erecting men's reports pertaining to the particular work are filed in the same way, and the system remains undisturbed until the final acceptance is received and the construction department turns the matter over to the treasurer for collecting the balance due and closing the affair. The papers pertaining to the sale and delivery of machinery may amount to only a few sheets, while with a building operation or large contracting work the correspondence may run into thousands of pages. In such cases, it is convenient to make a little sub-file for each special order, supplying separate folders for correspondence with the purchaser himself, with consulting engineers, with sub-contractors and the like, so that one or more of these folders may be taken out as desired without involving the necessity of going through all the papers to find letters pertaining to any one party.

The later filing of letters from purchasers requires special study. It happens frequently in some lines of business that several different names are connected with the work as principals between the first inspection and the final conclusion. Thus the sale of engines for an office building comes up first as an inquiry from a sub-contractor for work on the building. A little later the names of the architect, consulting engineers, general contractor, and real-estate company owning or handling the property appear, and correspondence from all these belongs to the same work and should be filed together. After the building is finished and equipped and turned over to the purchaser, a new name may appear for the building and another corporation take hold, and all previous names be quickly forgotten. It is therefore

necessary for the engineering department, which has furnished machinery to such a combination, to keep a record of the present name under which the job is known, and this may be done by a simple cross-reference in the letter file between the old and new names, with an appropriate entry in the serial record of shop orders. This being carefully kept up, reports or information can be readily obtained from the manufacturer, and the good will of the customer retained to great advantage.

There are several important divisions of correspondence aside from those of the sales and construction departments. Purchasing supplies brings in many quotations and accompanying letters, which are best filed by classes of material offered. Letters from persons seeking employment are conveniently filed by themselves in folders grouped by the class of work the applicant desires. In this way, reference can quickly be had to the names of persons seeking employment in offices or shops to fill vacancies in the several trades, which would not be the case if the letters were filed by the names of the individuals writing them.

Whatever system of filing is used, there is no safeguard against the loss of letters carelessly placed in the wrong files, other than attention on the part of the filing clerk. It is therefore absolutely necessary that the files be consulted by but one responsible clerk, or in the case of sections assigned to the departments, by one person in charge of each section, and no one else. With proper care given to the handling of the correspondence files in their daily use, the vertical system of filing, and classification according to subjects rather than according to names, it is possible for one man to handle an amount of business which would be very much beyond the capacity of the most able man working with the old system of alphabetical files.

The universal use of the typewriter and of rapid copying methods has much increased the amount of correspondence by facilitating the writing of letters, in many cases to the disadvantage of the business world by multiplying useless verbiage. At the same time, the free use of correspondence methods has made it possible to supply manufactured products to purchasers at vastly increased distance, and to study their needs in a way which could not have been done with any less easy method of obtaining and transferring information.

MECHANICAL REFRIGERATION ADAPTED TO RAILWAY TRANSPORTATION.

By Dr. Joseph H. Hart.

Dr. Hart's suggestions have very great interest and possible importance for both the railway and the mechanical manufacturing world. Their adoption would mean, on the one hand, the betterment of economy, of convenience, of time, and of capacity in cold-storage transportation; on the other, it would mean a large and profitable expansion in the installation and the operation of refrigerating plant. They deserve, therefore, the careful consideration of traffic managers and of machinery builders.—THE EDITORS.

THE quantity of perishable freight requiring transportation, and the utilization of refrigeration for its preservation in the United States, are daily increasing by leaps and bounds, and the limit is not yet in sight. This tremendous increase in freight tonnage is doubtless responsible for a considerable amount of the imperfection existing in the refrigerating methods in operation today; but there is no doubt that, as a whole, the application of mechanical refrigeration to transportation is in a most chaotic condition. With mechanical refrigeration perfected as an efficient process, and with capabilities in the production of refrigeration (and even of ice, at a much less cost than is required even in handling and storing the same from natural sources), still the great bulk of all perishable products is preserved in transit by means of natural ice and ordinary refrigerating methods.

The difficulties inherent in the application of mechanical refrigeration to this process are more imaginary than real, and the cause of the arrested development along this line is to be found more in the unusual and unnecessary processes which have been attempted than in any inherent difficulty in the matter. Further, mechanical refrigeration-machine manufacturers have found an expanding market with many new applications always at hand and generally a large excess of orders; and hence, the introduction along lines that have presented apparent difficulties have been neglected in favor of movement along lines of least resistance. It can be said that there exists no inherent difficulty in the thorough and efficient application of mechanical refrigeration to railroad practice and its necessities, although the lines ordinarily pursued appear to discover many. A general consideration of the entire problem from the viewpoint of the railroad

engineer, and from that of the refrigerating expert as well, is necessary for a full understanding of the difficulties involved; but when these are once considered and thoroughly understood, the solution of the problem is comparatively easy.

Thus the problem from a mechanical-refrigeration standpoint is not difficult. Refrigerating units of capacity much smaller than that involved in a refrigerator car are in practical and efficient operation today. Unusual temperatures are not required, and the quantity of heat involved is not prohibitively small per car. Further, while under some circumstances water and space and power enter as important problems from the viewpoint of the individual or automatic refrigerating machine, from the broad standpoint of railroad practice in general these factors become of minor importance. Thus from the railroad point of view the conditions which are of prime importance are primarily reliability, space, first cost, and care. Under this latter head, of course, come cost of maintenance and the depreciation factor; but these are the only necessary considerations from the railroad point of view. From the shipper's point of view—and, of course, incidentally, that of the railroad as well—the question of ventilation and moisture enter as important factors.

Now to understand fully the difficulties involved and their relative importance in this particular problem of railroad refrigeration, the best results can be obtained by a complete review of the present methods in operation, their faults and inadequacy, and the various attempted improvements now under way. Thus today on railroads we have the following refrigerating systems:—

The great majority of cars are cooled by the insertion of ice in suitable compartments at various stations en route. This ice, in the great majority of cases, is natural ice collected in ice houses from suitable localities along the railroad and in some cases is shipped by them from suitable collecting localities to convenient distributing points or car-filling sheds. In some cases, comparatively few, this ice is produced by mechanical refrigeration, from the operation of large units with considerable efficiency; and there is no doubt that this practice is bound to increase as it presents the simplest and most obvious way out of the difficulty. Ice can certainly be manufactured and used much more cheaply than it can be harvested and stored by the ordinary methods.

The next step in the process is the attempt to develop automatic refrigerating machines for individual car operation. At the present date it can be said, in a general way, that almost without exception

such installations are more or less complete failures. The problem is attacked in an unsatisfactory manner, and the inherent conditions are such that failure becomes almost inevitable. To begin with, the automatic refrigerating machine itself is not today in a condition which would warrant any such application. A large number of automatic refrigerating-machine plants have been organized but almost without exception these have proved inefficient and the companies have gone to the wall. The difficulties inseparable from the problem are such that almost every automatic refrigerating machine in existence today requires constant care in its maintenance or at least a large amount of attention. Under these conditions to complicate the matter further by constant vibration and jolting, such as are incident in railway practice; to operate under such conditions that the supplies of water and power are often inaccessible or subject to accidental stoppage; where space is limited and first cost is an important factor, and where, further, the very worst of care and attention becomes almost inevitable—this is a combination with which few engineers would care to struggle. Thus the majority of attempts to develop refrigerator cars involving their own individual refrigerating unit, have been limited to persons not wholly familiar with the entire situation or fitted to judge of the conditions. The possibility under the present conditions of an automatic machine being developed to fill this field satisfactorily and become general in its application is extremely remote.

Now, in order to see the lines along which engineering progress should continue with best hopes of success, it is necessary to consider further one or two of the attempts which have already been made. As one illustration we have the remarkably efficient process known as air cooling in use by the United Fruit Company in the shipment of bananas. Large refrigerating plants are constructed, at convenient distributing stations, which cool air to a suitable temperature. This air is injected into the cars and allowed to fill the interstices of the cargo until it is all thoroughly chilled. The cars are then partially closed, and radiation prevented as much as possible, and under these conditions the cargo is carried on to the next distributing point, where a new supply of cold air is injected and suitable cooling produced. This, of course, represents one of the minor and easiest applications of mechanical refrigeration in this field, but it has been accomplished along scientific lines. The temperature required is a comparatively mild one, the quantity of refrigeration held in the car units is reasonably large, and this method was adopted because it sup-

plied the ventilation rendered absolutely necessary by the nature of the refrigerated product itself. Bananas require for their preservation a temperature of about 65 degrees F., with free ventilation. This has been secured by keeping the cars open to a certain extent through suitable outlets, so that the air can be changed as desired. Today bananas can be shipped considerable distances without fresh refrigeration, and the process is extremely efficient.

The application of this process elsewhere from a refrigerating point of view is limited on account of temperatures required and quantity of refrigeration necessary with other products. Thus meat requires a much lower temperature and the refrigerating units are in many cases much smaller. This means that radiation is much greater and the storage capacity of the car for cold more limited as well. The problem, however, becomes simply one of heat units and insulating materials. And there is no doubt that many other products will soon be shipped by the same process now used in the banana trade.

Automatic machines are divided into two classes, the single-car-unit machine and the train-unit machine. Both of these are inefficient in comparison to stationary units, and unnecessarily bring in a number of additional features which tend to diminish efficiency. Thus all the difficulties inherent in electric lighting of trains by single-car units or by total-train units enter again here, and in ten-fold degree. The refrigerating machine is not so simple that it can be carried around and operated under its present condition with the minimum only of care and attention that it will almost certainly receive here. The air-cooling device is limited in its applicability by the very nature of the process, from a refrigerating point of view and from the nature of the duty required. In order to see what methods are applicable to this service we must review the situation briefly from the standpoint of the refrigerating engineer.

There is no doubt (and it becomes almost unnecessary to make the statement) that the ammonia machine is in all probability the only machine capable of adaptation to this work under present conditions. Ammonia occupies a position in refrigeration analogous to that of water in power production; it is generally recognized as the best substance for the conveyance of heat. Now, ammonia machines operate in two ways, utilizing either direct expansion or indirect (or brine) cooling. Further, the direct expansion may be used to cool a substance directly, or indirectly by means of air. Further, the indirect brine system, in turn, may be used to cool directly or indirectly by

means of air. As a further development come the two types, (namely, the absorption machine and the compression machine) in the production of mechanical refrigeration—the compression machine with its great efficiency for mild refrigeration, and the absorption machine with its capability of utilizing exhaust steam and its increased efficiency in the production of extreme cold. These special characteristics, however, are not important to our present consideration; the installation in any given case must be adapted to the conditions at hand, choosing that which will show the best efficiency. The probable outcome is the development of a correlated system composed of units of both types, utilizing the exhaust steam from the compressor to operate the absorption plant. Thus whatever system is used, ammonia is the operating substance, and refrigeration from it can be applied in a large number of ways. Its mode of utilization, of course, depends to a certain extent upon its production, cost, and efficiency. Thus, there is no doubt that the large-unit absorption plant, or possibly a combination plant, operates much more efficiently in the production of refrigeration than does a small one, and that in a general way the larger the unit involved the more efficient and cheaper becomes the process of development. This is a consideration which cannot be neglected in railroad work any more than in any other, and the attempt to divide refrigerating apparatus into car units or train units is a step in the wrong direction, with diminished efficiency as the result. The tendency is irrevocably towards larger and larger units, and undertakings which clearly recognize this prime condition in economy and embody it in their operations have an advantage at the very start over their competitors, which in general can rarely be overcome. In all probability the single-car refrigerating unit and the train-system unit will never come into general use, and their isolated application will diminish more and more with lapse of time.

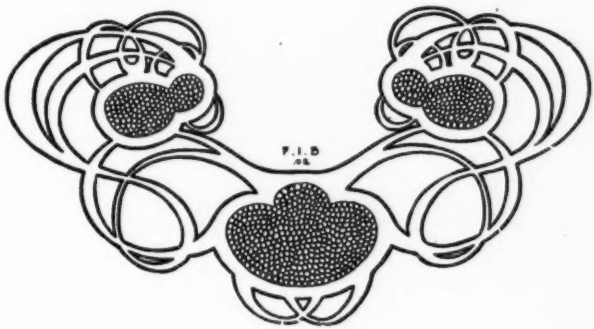
Now, with the large refrigerating unit and the production of refrigeration in enormous quantities at fixed points accepted as a prime condition, the problem simplifies itself somewhat and becomes one merely of method of using the refrigeration when produced. This in reality is the situation today. Large ice houses exist, and furnish at stated intervals refrigeration which continues, but gradually becomes weaker, until the next refrigerating station is reached. The use of ice and especially natural ice, outside of the question of cost, is objectionable in itself. Ice is rather inconvenient to handle in its natural state and after storage is dirty; it occupies considerable

room in the refrigerating car and is clumsy in its adaptation, and, further, it requires considerable manual attention in its installation. The amount of refrigeration involved is practically greater than that involved in any other space of equal dimensions, since the latent heat of ice is large. The large quantities of ice employed, however, in refrigerating cars are not absolutely necessary and the quantity of refrigeration carried can be cut down considerably, whereas, further, the advantage gained from heat concentration in the ice is often lost by the injudicious packing and the absence of fore-cooling. Thus it is universally recognized that ice is extremely objectionable in the natural form, its cost is high, and it cannot compare with mechanical refrigeration. In its application, moreover, there is a loss all along the line which seems absolutely unnecessary. There is a loss in its production, there is a loss in its handling, and there is a loss in its refrigerating effect. Seldom if ever are cars packed with ice and allowed to cool off to the ice limit and then repacked before shipment. They come in, are loaded up and then carried on—whether the refrigerators are full or not makes little difference. The space occupied is extremely large and inconveniently placed. The cost of handling is enormous and the moisture always present is a very objectionable feature.

The utilization of air as shown in the United Fruit Company's practice, although manifestly desirable in many features, is practically impossible in many other applications, on account of the quantity of heat involved. The only answer to the problem is the utilization of brine in a method similar to that of air as exemplified and utilized in the best installations today. Refrigerating units could be increased enormously. The brine could be produced and stored at minimum cost with maximum ease of handling. Refrigerator cars could be so constructed as to utilize all available space—often an impossibility under the present system—and to produce much superior refrigeration. Thus often a large portion of the car is set off for an ice chamber, in present-day work. With brine, this chamber could be thinned out to include all walls, floor, and ceiling, except the door, and even this might be rendered available. Good insulation could be installed. The carrying capacity of the car both for merchandise and for refrigerating material or brine could be much increased, so that the refrigerating capacities actually available would be larger than they are now. Fore-cooling could be secured readily by rapid installation, and the brine changed just before starting. If necessary, additional brine reservoirs could be carried on trains as a safeguard in an

emergency, and if desirable, their contents could be pumped through the system by the engine.

No attempt at modern insulation for refrigeration is made today in ordinary refrigerator cars. With suitable insulation a layer of cold brine, if cooled off sufficiently and made to occupy a small layer completely around the car (and, if necessary, in small partitions in the interior) would carry fully as much refrigerating power as the present ice system and would allow much more space. Extremely cold brine could be readily produced by the absorption machine and it could be handled with a great saving over present-day methods. The cars could empty almost automatically into reservoirs immediately under the track. Pipes could supply the fresh refrigerant from a reservoir in the plant by almost the same process, or possibly an automatic one from above, and the train could be stored at once with cold brine, wait a short time to cool off, could be partially or completely discharged, and then refilled, in an interval of time depending simply upon the size of the discharge pipes and the capacity of the plant. The cost of installation of the entire system would be much less, even including machinery, than it is now, and the saving in almost every department would be large. The utilization of exhaust steam in an absorption plant and in large units, as large almost as any now in existence, would present new features for development in the utilization of the live steam for power and other purposes, and the limit of increase in efficiency by this process can be hardly foretold.



PROFIT MAKING IN SHOP AND FACTORY MANAGEMENT.

By C. U. Carpenter.

X. EFFECTIVE ORGANIZATION IN THE EXECUTIVE MANAGEMENT.

With this issue Mr. Carpenter closes his series which began in January last—a study of effective works-management methods, marked throughout by the clear sight, the fair mind, the direct dealing and the strong vitality of the author. He has been compelled to the writing, amid incessant and insistent claims upon his time by his active work as president and manager of a great manufacturing company, by his keen interest in the promotion of better ideals in industrial organization. It is largely a labor of love, freely devoted to the advance of his profession. And it bears throughout the stamp of tried, practical success.

The articles previously published in Mr. Carpenter's series discussed, first, the general methods of examining into the condition of any manufacturing business so as to discover the existence of waste and loss and to determine the "sticking points"; second, the nature and the working of the "committee system" of factory administration; third, the reorganization of the designing and drafting departments; fourth, the great importance and value of the tool-room as a source and spring of profitable methods; fifth, the general conditions necessary for manufacturing at minimum cost; sixth, methods for fixing standard times for manufacturing operations; seventh, minimizing the time of assembling; eighth, stimulating production by wage, stock, and cost systems; ninth, the upbuilding of an efficient selling organization.—THE EDITORS.

THE preceding articles appearing in the series which began in this magazine last January have dealt somewhat fully with the defects existing in the average manufacturing concern as regards its organization and its selling and factory methods and systems, and have indicated some methods of overcoming these troubles that have been found effective in everyday practice in the upbuilding of run-down concerns.

This discussion would not be complete unless the executive division, whether it consists of one man or twenty, were given some treatment. For indeed the troubles—the defects, both in organization and methods, that may be met with in selling force or factory—exist in particular strength in many an executive division, and cause infinite trouble. The small jealousy that impels one man or one group of men to underrate the value of work done by others, the lack of unity of purpose which often leads one set of men to block surreptitiously the good work of another group, often works incalculable loss.

The larger and more complex the executive end of a business, the more important does it become that great care be used in organizing it in such a manner that each member of this group shall be allowed to do his own work without interference from others, and

yet, at the same time, that each member shall bring to the business and to the most serious problems in the business his best judgment on the business as a whole, and pour into a common reservoir his reason for objection, his particular plan, his best thought, his enthusiasm, his best self, for "the good of the business."

As long as the executive force work in unison, the balance of the organization will generally do likewise. Let there be discord and lack of harmony amongst the heads of the business, and there will be an instant lining up of forces in opposition one to the other from one end of the working body to the other. This lack of harmony in the executive division arises for reasons similar to those that disintegrate the balance of the organization and cause it to lose so much of its latent power. The only cure, in my opinion, is the old one of "getting together." The general ideas already expressed in earlier numbers of this series relative to the formation of committees are particularly applicable here.

It is my intention to illustrate briefly the work of a group of executives, showing how the work of each one is related to and interlaced with the work of all. Before doing so, however, it is advisable to consider a few suggestive forms of reports from different sections of the organization which are very necessary in order that a full grasp upon the business may be held by those managing it. Of course no attempt to outline fully any system of reports generally applicable could be successful. The general forms of the ones suggested, however, are adaptable to many differing conditions.

Executive Reports from Selling Division.—As a fundamental form of report invariably necessary I submit one (page 492) which shows how much business *must be done* in each line of product and in each territory. This must show the volume of sales required in detail. As against this there must be set the allowable factory costs, together with allowable costs of extras of all character. In addition to this, there must be carefully calculated out the allowable selling expense, including all items, such as salesmen's and managers' salaries, commissions, traveling expenses, advertising, etc. There must further be shown the allowable general expense, such as rent, insurance, taxes, telephone, telegraph, office salaries, etc. In all cases allowable percentages should be carefully worked out.

The "allowable amounts" must be calculated from close knowledge, first, of how much profit the concern should make; second, of how much profit should come from each territory considering the possibilities of the business and expense of conducting it. When these computations are made for each territory, covering selling prices,

factory costs, selling and general expenses, together with percentage calculations, showing the proper relationship of all of these items, you have a solid foundation upon which to work and from which to drive for business. Of course this should be carried much further within the selling division. Each salesman should have his record to strive for. His showing should be based upon the same idea.

	%	N. Y. Branch.	%	Phila. Branch.	Etc.	
Required Sales. Amounts (Classified).						
Factory Costs. Amounts (classified) ..						
All other Cost Items Classified						
Gross Profits						
Selling Expenses (Classified).						
(a) Salesmen, salaries..						
(b) " commissions						
(c) " expenses ..						
(d) Mngrs., salaries ...						
(e) " expenses ..						
(f) Advertising						
Total Selling Expense						
General Expenses (Classified).						
(a) Rent, Insurance, Taxes						
(b) Office Salaries ...						
(c) Telegraph and telephone						
(d) Miscellaneous						
(e) Legal, etc.						
Total General Expense						
Total All Expense...						
Net Profit Required..						

STANDARD SELLING RECORD.

This Record is used, first, for showing Required Sales and Allowable Expenses with percentages; second, for showing Actual Sales Made and Actual Expenses Incurred and percentages. The use of the same form facilitates comparisons.

Having these data, the next step naturally is to supply the exact information as to sales record and expenses. The sales record, as far as the selling division is concerned, should, of course, be made up daily, the expense items being roughly calculated upon a percentage basis. The monthly sales record should, however, be complete. It should follow exactly the lines of the standard selling record illustrated above, the sales data being taken from the sales records, the expense data directly from the accounting department. This leaves in the mind of each manager of a selling division no iota of doubt as to what *must* be done, and by comparison he sees how much he has gained or how far he has fallen behind. Such reports provide the

executives with accurate and usually much needed indices of sales conditions. They are especially valuable where the business done is in the nature of long-time contracts under which deliveries are made for long periods after the actual sales are recorded.

Other selling-division reports, such as those showing the distribution of sales, the covering of territories, the development of the selling efficiency of the organization, etc., and the condition of competition, would naturally be made and need no discussion here.

Factory Reports. — In preceding numbers of this magazine, both in this series and that appearing in 1902, the question of factory reports has been quite fully dealt with. From the data secured through the suggested methods many interesting and important reports are derived. These are:

1. Factory Output and Efficiency Report.

This report may be adapted to meet the requirements of departmental efficiency reports also. It should compare the results for various periods with the results of like previous periods, either as a total or an average. By noting the number of employes, pay rolls, and material purchases, and comparing the figures with values of output and inventories, a very accurate idea may be secured as to the relative efficiency of the entire shop or any department.

2. Progress-of-Work Report.

To every executive managing any shop, and particularly those working

FACTORY EFFICIENCY AND OUTPUT REPORT.

Compare weekly or monthly results with averages of a preceding period of six months.

Week Ending	No. employes	Output		Hours Worked		PAY ROLL						Material Purchased		Inventory	Miscel. Charges	Factory Balances	Costs					Increases or Decreases	
		No. of Machines	Values	Total	Over Time	Labor Direct	Piece Work	Day Work	Indirect	% Jobs reaching Standard Time		Direct	Indirect	(Subject to proper classification)	(classified)	(classified)	Material	Labor (classified)	General Wages	Total		Where?	Why?

DATE.....

Name and Location of Customer.	Description of Order (Briefly).	Factory Order No.	Date of Order	Must Erect by	Must Ship by	What is Shipped	Condition of Orders (Classified)			
							Drawings % Done.	Material % Received	In these columns place the different classifications of each contract, showing % finished	General.

Signed—Committee (by Sec'y).

FACTORY PROGRESS REPORT (WEEKLY).

upon long-time delivery contracts a weekly progress-of-work report will prove invaluable. If this report were to be made up from the cost records, the task would be a great one. It can be handled very easily and simply, however, by the committees. Each foreman should have a keen knowledge of the progress of his portion of any job. These men, together with a bright secretary, in one of their regular meetings can easily and quickly formulate such a progress-of-work report as suggested. The advantages of such reports are many.

First, they provide an alert executive with a most important index as to progress of work and enable him to "pound the shop" for any work that he can note is falling behind.

Second, they force upon the attention of the foreman individually the progress of each job in his own department. They *compel* him to accumulate a very useful knowledge of his own work—oftentimes lacking.

Third, they place the factory in possession of data making it possible to give the selling department delivery dates which can be met.

Fourth, they are an invaluable aid to the treasurer, enabling him to predict with some degree of certainty when his collections will come due. Especially valuable are they in cases of large contracts calling for partial payments as work progresses.

Such reports, covering a very wide variety of work, have for a long time been made out by our factories on Saturday morning, arriving on my desk the following Monday. Meetings with interested heads of financial and sales divisions immediately follow, and as a result there exists the closest possible touch between the several divisions upon the one important point—Production.

Executive Report.—The report of paramount importance is the one illustrated on this page. It should be produced monthly from the books of the concern. The several divisions are self-explanatory.

DATES..... from..... to.....

	New York Branch.	%	Philadelphia Branch.	%	And all other Selling Divi'ons.
Deliveries (Classified).					
Total Deliveries					
Factory Costs (Classified).					
Total Factory Costs.....					
All other Cost Charges (Classified), *e. g.*, Delivery—Finishing.					
Total All Other Costs....					
Total Delivered Costs.....					
Gross Profit					
Deduct Selling Expense (Classified).					
Salesmen, salaries and commissions					
(Depmts.) (a)					
(b)					
(c)					
Salesmen, expenses					
(Depmts.) (a)					
(b)					
(c)					
Mngrs., salaries					
" expenses					
Advertising					
Total Selling Expense.....					
General Expenses (Classified).					
Office Salaries					
Rent, Insurance and Taxes..					
Telegrams, Postage, etc.....					
Stationery and Printing.....					
Light, Heat and Power.....					
Maintenance					
Adjustments and Losses					
Legal					
Miscellaneous					
Total General Expense....					
Total Selling and General Expense					
Profit (black). Loss (red)					

EXECUTIVE PROFIT AND LOSS REPORT.

Comparing this with the selling-division reports, there is provided a full index of business conditions. Couple it with factory reports already mentioned, and a monthly balance sheet follows.

Having now described in a general manner the detail, I can perhaps best illustrate the value of the methods advocated by quoting a programme of action taken "from actual life" by a committee of executives of a very large concern. The committee is formed of the president, the general manager, the treasurer, the sales manager, and the factory manager. The understanding is general that heads of departments shall frequently be called into their conferences. A typical program is as follows:

President; acts as chairman.

General Manager.—Critical discussion of business conditions, with especial reference to those sections in which the records show a decided falling off in business. Discussion with sales manager as to the reasons for this condition. Discussion develops that a new form of competition has arisen in that particular region. Steps are taken immediately to meet this before it grows to greater strength.

General discussion of executive report. An analysis shows where the greatest profits in the business lay and where the greatest losses occurred. Discussion of expense items shown on executive report.

Sales Manager.—(a) Reports on sales conditions in various territories and orders coming therefrom.

(b) Competition; what must be done in way of new methods or new product to meet it.

(c) Progress of training department.

(d) Expense.

Factory Manager.—(a) Discussion of factory output and efficiency.

(b) The progress-of-work report.

(c) Report on progress of new factory methods and inventions.

Treasurer.—A discussion of financial outlook with especial reference to the future deliveries as outlined on progress-of-work report.

In this concern, formerly handicapped severely by a lack of knowledge of such important points, a revolution was worked through the adoption of the simple and direct system.

And so I maintain that the adoption of these simple and natural methods will change an organization burdened with jealousies, handicapped by misunderstanding, held back by lack of knowledge, lack of progress and general inefficiency, to one comparatively free from personal enmities, led by a sense of certitude as to actual condition in field and factory; constantly impelled, even in the smallest details, toward a greater degree of efficiency and surcharged with the feeling of true enthusiasm—the will to work "for the good of the company."

EDITORIAL COMMENT

IT is doubtful if there has been heretofore any spasm of business depression which was so much the result of a state of mind, with so little really the matter, as that which now hangs half-poised on the balance of the times. Every fundamental of prosperity, and stable prosperity, is sound. We have not been carried away by any inordinate temper of inflation—over-trading, over-building, over-expansion. Indeed, we have scarcely provided amply enough for the care and handling of the enormous stores of natural wealth piled up by our miners, farmers, planters, producers in every field. Nor is there any slightest menace from any unsound currency system. Every event and every phenomenon confirms the conclusions formulated by Mr. Del Mar in our October issue :—"The foundations of our welfare are solid. Aside from a remediable constriction in the monetary field, there is nothing in the situation to warrant any apprehension."

It is a "psychological panic." The blame for the abnormal state of the public mind, it has been wisely said, may best be fixed later.* At present the pressing need is to cure the disorder. The fear is individual. The individual depositor fears that others may precipitate a disastrous run on his bank—and heralds his fear by trying to get first in line. The individual bank fears losses through disturbed conditions—and by calling loans and denying accommodations so as to build up its reserve, precipitates the very condition it dreads. The individual manufacturer fears cancellation of orders by his customers, and by cancelling his own purchases he plunges the whole community into the depression all are trying to avoid. A wholesome and wholly practicable remedy lies in active, instant, frank conference between financial, commercial and industrial leaders. The sense of sympathy, support and security which co-operation brings would put the whole fund of courage at the back of each timid individual, and the fear which is working the damage would vanish as swiftly as it came.

This is no time for hoarding of funds, for retrenchment in manufacturing, for piling up of bank reserves. Not for years has any such opportunity been afforded for money actively employed to make more money for its owners. Whether loaned to well assured business or invested in sound securities, the certain reward is almost unprecedented for those who have the wisdom and the courage to seize the opportunity now. Later, when everyone sees it, the opportunity will be gone.

No great courage is necessary ; only common-sense. If—at first perhaps locally and then more widely—those who have the money and those who have business will get together and determine that accommodation shall if necessary be stretched, rather than restricted, and that operations shall be continued at the highest possible point, rather than curtailed—the trouble will disappear like mist before the sun.

To manufacturers especially it should be plain that retrenchment begets retrenchment, and the wave swings back and forth with rising intensity at each return. The maintenance of business at the highest schedule which can possibly be managed, at almost any temporary cost, is better than contraction with its attendant loss of the "intangible assets" of organization, personnel and goodwill—intangible, but the most valuable possession of any enterprise. Better to borrow $100,000 at 10 per cent—or 20 per cent—for three months

* Cordial acknowledgement is made to Mr. H. L. Doherty's address before the American Trade Press Association for many suggestions herein.

than to let a plant investment of $1,000,000 lie idle for a year and more, to be with difficulty and cost brought back to efficiency at the end of that time.

Such a movement of co-operation between financiers and business men should be started simultaneously throughout the country, and probably would be most immediately effective in the smaller cities and the distinctively manufacturing centres. The point is to make a common fund of the underlying confidence everyone feels in the essential soundness of conditions throughout the country—to pile up our faith in the future and in one another until it rolls in an uplifting wave of realized prosperity, which will sweep back the floods of doubt and pessimism beyond any power for evil. The admonition can be put very briefly: Get together. Do it now!

* * *

THE three great factors in the profitable employment of capital in manufacturing are materials, superintendence, and labor. Of these, the first —natural resources and products of the soil—have generally been a matter of national solicitude and often the cherished object of national economic policy. The second—scientific works-management—has enlisted the earnest study of some of the clearest-sighted and most ingenious engineers and has practically developed into a new profession and created a new literature. But the cultivation of the third—of the volume and grade of labor needed to support and extend the great manufacturing industries of our day and of the day just ahead—this (in England and America, at least) has been left almost wholly to chance.

Some few of the largest of our industrial establishments foresaw, years ago, the necessity for training a new generation of workers; now the need is becoming widely manifest and is beginning to take a prominent place in the discussions of employers. Interest in the subject has grown remarkably since, just a year ago, we published Mr. O. M. Becker's study of existing and possible apprenticeship systems under modern conditions. And as employers are turning favorably to plans for industrial education, the attitude of organized labor toward the movement, so well set forth in Mr. Stratton's article leading this number, becomes of active importance.

It is of much interest to compare British conditions, as proved in the recent Engineering Trades Agreement of which a digest appears in our Review of the Engineering Press this month (pages 504-507). It is noticeable that no fixation by the unions of the proportion of apprentices to journeymen is conceded by the employers, and that industrial education is more than "tolerated" by British labor organizations—it is solicited, and employers are asked to promise to encourage the novice in obtaining it.

The political economy of trade unionism has rarely been broad-minded or far-sighted; it is therefore the more interesting and hopeful to see it in this instance laying so safe and wise a course. The pressure of competition in the engineering trades is no longer wholly domestic, but to an increasing extent becomes international. Germany is a rival to be reckoned with; and the part which systematic, specialized industrial education is playing in her expanding commercial programme was impressively shown in the thoughtful studies by the late Louis J. Magee published in these pages January-March, 1906.

The American mechanic, of all concerned, is least in position to allow any fraction of American mechanical supremacy to pass to outsiders through decadence of the rank-and-file personnel that have made American machinery and American industries the admiration of the world.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE QUEBEC BRIDGE DISASTER.

OPINIONS OF THE LEADING BRITISH TECHNICAL JOURNALS AS TO THE CORRECTNESS OF THE DESIGN OF THE COMPRESSION MEMBERS.

Engineering—The Engineer.

THE two preceding issues of THE ENGINEERING MAGAZINE have contained reviews of articles published in *Engineering News*, which were representative of American sentiment on the failure of the Quebec Bridge. It is interesting to compare with these the conclusions reached by the leading representatives of the technical press of Great Britain as shown by the following extracts from *Engineering* and *The Engineer*.

The editorial comments of *Engineering* are based on a report by Mr. Frank W. Skinner, who made a personal investigation at the scene of the wreck. Stress is laid upon the fact that the chord member which was responsible for the initial failure was found bowed 1½ to 2 inches out of line three days before the wreck, while carrying little more than one-half the load for which it was designed. A heavy responsibility is placed upon the local engineering staff for the appalling loss of life. The clear duty of the engineer in charge of erection, in view of the unmistakable signs of crippling in the strut, was to close down the work immediately pending a thorough investigation of the cause.

"Mr. Skinner's article fully establishes the fact that bad design, and not bad material, was responsible for the catastrophe. The conditions at the time of the collapse were, he states, everywhere normal or favourable, and the material and workmanship were both excellent of their kind; whilst the substructure, even after the accident, was found in practically perfect condition. Obviously, therefore, the fault must have lain in the general or detailed design of the superstructure. There are no doubt a number of points in which this general design is open to criticism, but the really fatal error appears to lie in the system of bracing adopted for the lower chord members.

"The bracing or latticing of these compression members was absurdly light according to English ideas. Taking the lighter strut, No. 8, first into consideration, few engineers on this side of the Atlantic would care to try and hold such thin and deep plates in line by merely latticing them across the top and bottom. The addition of a solid diaphragm-plate running from end to end at mid-depth would undoubtedly have made a better job. Presumably the reason why some such arrangement was not adopted lay in the supposed difficulty of transferring across to the pins the load carried by this plate; and hence the adoption of the design criticised. Although unmechanical, we are not, however, prepared to say that it was actually dangerous in this instance; but there are good grounds for believing that chord member No. 8, and, *a fortiori*, Nos. 9 and 10, were, on the other hand, in a somewhat parlous state. The bracing here was, in short, incapable of developing the full bending strength of the web-plates. If those of member No. 8 were laid flat side by side, over supports 55 feet apart, they could

sustain a uniformly-distributed load of about 53 tons, with a stress in the metal of some 10 tons per square inch. Treating the complete strut in the same way, a load of 40 tons would cause a stress of about 10¾ tons per square inch in the bracing members. Each 4-inch by 3-inch angle would then, it is true, take a load of only about 7½ tons on an area of 2.48 square inches; but as this is applied eccentrically through one web only, the actual stress in the metal would reach the figure stated. As a matter of fact, the rivets might, indeed, go first, since these are of ⅞ inch diameter only. The bending of these bracing bars under their eccentrically applied load would, moreover, allow the webs to get out of line, thus accentuating the effect of their light scantlings.

"Unless the load on a strut is applied absolutely centrally, a bending moment is developed, causing an increase in the stress on the metal. In the case of the chord members, this additional stress on the plating is not in itself serious, since the length of the member is only about ten times its width. The same cannot, however, be said as to the stresses due to shear, which are simultaneously developed on the bracing by an eccentrically-applied load."

A mathematical discussion is given of the effect an eccentrically-applied load would have on this member and it is shown that the bracing used was quite incapable of developing the full compressive strength of the strut. "This will be evident when it is remembered that the stress on the bracing is directly proportional to the eccentricity, whilst the direct stresses on the plate-webs increase much less rapidly when the eccentricity is increased. Thus with zero eccentricity of the thrust the direct stress in the case of chord member No. 8 is about 13 tons under the combined action of dead load, live load, and wind load. With an eccentricity of 1.5 inch the direct stress would only be increased by some 25 per cent., making a total of, say, 16½ tons per square inch.

"The bracing, on the other hand, with the same eccentricity, would be subject to a stress of 24 to 25 tons per square inch—that is to say, it would be strained up to practically its ultimate strength, if constructed out of 26-ton steel, as in this case.

"Chord member No. 9 is longer than No. 8, and the load on it is greater, so that a lesser eccentricity would probably be fatal to it, were it ever called upon to take its intended maximum load. At the time of the disaster the stress here is said to have been only about 8 tons per square inch, and a greater eccentricity than above calculated might then be needed to endanger the bracing. At the best, however, the margin of safety appears very small, and the construction adopted is certainly unmechanical. In the river-arm the struts are still longer, and the bracing has here, accordingly, a still smaller margin of safety. It is to be presumed that the Commission which has been appointed to report on the failure will test some large models of these struts. It is to be hoped that such tests will not only include experiments on the models centrally loaded, but that the investigation will be extended to cover their behaviour under eccentrically applied thrusts. We are convinced in that case that the bracing will prove wholly inadequate to develop the full strength of the specimens. This view receives additional confirmation in Mr. Skinner's article, where he notes the circumstance that in the case of the struts wrecked by the fall the bracing gave way before the struts crippled.

"A different hypothesis as to the immediate origin of the catastrophe is also suggested by Mr. Skinner. He notes here that the lower chord members near the pier did not merely abut on the main pin, but were continuous across the latter, thus introducing the bugbear of so many American bridge engineers—viz., indeterminate stresses. To English ears the suggestion that a mechanically designed detail such as this was responsible for the accident sounds somewhat strange, since it is perfectly well known that riveted structures make by far the best bridges, in spite of a theortic possibility of uncalculated secondary stresses. It is impossible, for instance, to calculate with accuracy the stresses arising in a common plate-girder, yet every railway engineer knows that such girders give less trouble under traffic than any other type of small-span metal bridge.

"This insistence that all structures shall be statically determinate seems to be the special fad of one particular school of

American bridge engineers. The idea rests on a theoretical basis only, and has no support from the teachings of experience. We know of no case in which a structure has failed merely through being statically indeterminate, whilst the rigidity gained has great practical advantages; and where such structures have failed through defective material or overloading, the wreck has not been practically instantaneous, as at Quebec, but has given time for the majority of those endangered to get clear.

"Further, it should be noted that in actual practice American pin bridges are no more free from secondary stresses than properly-designed riveted trusses. Bearing in mind the frictional resistances involved, it is inconceivable that the pins actually rotate in the eyes of the links at each change of load on the structure. In fact, if they did, serious wear might be expected, and in the absence of such rotation the bars coupled up are to all intents and purposes as rigidly connected as if riveted, and suffer from the same secondary stresses. As to the objection taken to rigidity of the joint between the chords across the main pin at Quebec, it would seem that it might be equally well raised against every other joint of the lower chord. Indeed, in the old days, pin-jointed compression chords were somewhat in favour, until experience proved decisively the superior advantages of constructing such chords in continuous lengths. Again, it seems well established that the strut which failed buckled sideways, and not vertically. If secondary stresses due to the rigidity of the joint past the main pin had anything to do with this, the member should have yielded in a vertical plane, and the contrary fact would *per se* suffice to confute the suggestion, were it not already sufficiently discounted by the teachings of experience."

The comments of *The Engineer* are in a different strain though touching, in the main, the same points.

"The bridge fell down because it was not strong enough to stand up. It is useless to ask why it fell down. The question is why it was too weak? There are four answers. The design was defective, or the material was not good, or the workmanship was bad; or, lastly, any two or all of the three may have been combined. Now, the whole American technical Press is agreed that the materials and the workmanship were excellent. It follows, then, that the bridge was not strong enough because the design was not good. There is no such thing as an absolutely good design for a bridge. Whether designs are good, better, or best, depends on the way in which they fit in with the ruling conditions; and it must be always kept in mind that a bridge which is on paper, all that can be desired, is not by any means certain to be the best when it is called into existence to span a ravine or a wide river. We may be told that all this is quite well known to engineers. Perhaps so; yet the Quebec Bridge has fallen down. Our contemporaries cannot for the moment get away from the belief that the design of the bridge is responsible for its downfall. Yet they admit that it was designed by the most competent men in the United States, and, to avoid the necessary implication, the hint is now thrown out that the behaviour of long and large struts is different from that of shorter or smaller struts in a way which has not hitherto been recognized.

"Our knowledge of the stiffness of struts is mainly of an empirical nature. The formulæ applied to them are complicated, and not entirely trustworthy. We are not in a position to assert of struts, as we are of beams, that the general formulæ for small sizes apply equally to those of great dimensions. Hence the argument that if the design was faulty it was faulty because precise knowledge of certain phenomena is lacking, has something to support it—at all events, for the time being. We may remark here that the design of the Forth Bridge presented also its quota of uncertainties. In that case the engineer, Sir Benjamin Baker, took no half measures. He threw science to the winds and built to cover his ignorance. What the bridge lost in elegance it gained in the certainty that no ordinary forces could overthrow it. There are times when it is the highest science to make the 'coefficient of uncertainty' enormously large.

"It is now confidently stated that the first failure of the Quebec Bridge occurred in the bottom boom of the shore span. This was built up of long plates secured to each other in groups, and then carried in the bridge on enormous turned pins fitting

carefully bored holes. The lateral stiffness of such a structure was comparatively small, and was augmented to the amount deemed requisite by cross bracing. The boom, however, buckled horizontally, and the bridge collapsed. This is the theory as far as it goes at present. We do not dispute its accuracy because we have no contradictory information; but it is worth notice that in this case one side of the bridge obviously fell first. Yet there is no slewing of the structure such as might have been expected, to be gathered from the photographs which have reached us. Let us ask ourselves whether a built-up strut of this kind is or is not likely to be the best? The assumption made is that if links and pins are suitable for tension they must be just as good for compression, always taking for granted that they are stiff enough laterally. This is, however, begging the question. The onus is shifted from the links to their stiffeners. When a bar is in tension all defects such as bends or kinks, or such like deformities, tend to elimination; the pull straightens them out. But with members in compression the effect of out of truth of line always tends to aggravation; the kink or bend will get worse, not better. In practice the trained engineer—in this country, at all events—meets the difficulty by providing a far larger margin of safety in the members of his bridge than he thinks enough for the tension members. The engineers of the Forth Bridge took no chances. The compression booms are mighty tubes. To calculate the principal stresses in any bridge, large or small, is a very simple affair. Graphic statics and a knowledge of the parallelogram of forces will suffice. But in all bridges there are secondary stresses. For these, in most cases, it is only possible to estimate. The secondary stresses are held by American bridge engineers to be less prominent and more easily dealt with in pin than in riveted structures. This, no doubt, and questions connected with labour, have had much to do in giving a popularity to the pin bridge in the United States which it has never enjoyed in any other country."

ELECTRIC POWER FROM BLAST FURNACES.

AN EXPOSITION OF THE ADVANTAGES OF A POOLING SYSTEM FOR ITS ECONOMIC DISTRIBUTION.

B. H. Thwaite—Iron and Steel Institute.

THE successful application of electric power to the driving of heavy rolling mills in several continental steel works, described in previous issues of THE ENGINEERING MAGAZINE, is a fact of great economic significance. The heat and power efficiency of rolling mill plants has always been very low. The steam boiler plant necessary to satisfy maximum requirements of rolling mills is usually large, and usually also intermittent in its working. The replacement of coal by blast-furnace gas as a boiler fuel was a great step in advance, but even under present circumstances condensation in steam pipes and frequent closing down of rolling mills for week ends or longer periods, during which blast-furnace gas is going to waste, still entail great losses. Steel works can be run at the highest possible efficiency only when all the blast-furnace gas is utilized for the generation of electric power for use within the works and, if above the requirements of the plant, for sale to surrounding industries. Technical difficulties in the way of the general gas-power electrification of rolling mills have been for the most part overcome, but the heavy expenditure necessary makes the reform impossible for firms of small or moderate financial resources. At the recent meeting of the Iron and Steel Institute, however, Mr. B. H. Thwaite outlined a system of pooling blast-furnace gas in iron-making districts which would materially lessen the burden and risk of the electrification of rolling mills and prevent any waste of power. The scheme has been tried and has proved successful in some districts in Germany and in at least one district in England.

"The basis of this programme is to pool the waste furnace gases from all the furnaces of an iron-making district independently of the ownership of such furnaces. The energy (electrically transformed) of

the different furnaces would be transmitted to a central distributing and transforming station, in which the current would be transformed to the voltage to satisfy different customers. Of course, there may be cases where the furnaces are so concentrated as to justify the delivery of the *furnace gases* to a pooling or central station for conversion into electrical energy, but usually it would be found to be more practical to transform the gas into electrical energy on the site of the ironworks, for transmission to a distributing central station.

"The first call on this power would, of course, be the satisfaction of the internal demands of the iron and steel works, the balance of power remaining being available for external distribution over a wide area, the extent of which, owing to the familiarity with and knowledge of the resources and safety of high-pressure transmission systems, is being yearly increased. When the author put forward the first long-distance electrical transmission project of over 100 miles in 1892, the line pressure then suggested was considered dangerous in the extreme. To-day, power is being easily and profitably transmitted over varying distances at very much higher pressures than those suggested in 1892. In 1892 the pressure specified was 20,000 volts; to-day, transmissions of 250 miles with 88,000 volts pressure are in daily service.

"The pooling programme proposed would be provided by a separate and distinctive joint-stock electric power organisation, on the lines of the county electric power companies, which sprang from the author's 1892 proposition, with the exception that a proportion of the output is preferentially allocated to the satisfaction of the power demands of the iron and steel works from which the gases are drawn. The balance could be transmitted to any group of customers whose power demands justified the cost of distributing mains and associated transforming stations, but a more appropriate field of demand for an all-the-year supply would be the satisfaction of the electric energy requirements of the many profitable electro-chemical and electro-fusion processes.

"Included amongst these processes, in which the demand for power would correlate with its production at the blast furnace, or from January 1st to December 31st, there are the production of high-class steel from selected scrap, special alloys, such as ferro-silicon and ferro-titanium, ferro-chromium, besides the production of carbides (silicon and calcium). Some of these processes could take the current just as supplied, in large or small proportions, and at any moment, so that the leveling up of the load or the demand could be readily effected—obviously an important factor in the economic production and sale of electricity.

"In the selection of the customers it would be advisable to secure the class of demand for operations such as mine pumping, electrolytic, and like processes, on which the supply could be turned on or off whenever available, so that the distribution of the current could be arranged to fill up any gaps in the demand.

"In large districts the power-driving requirements of the factories would provide a demand running into thousands of horse power, although the direct driving of important machinery will secure a great saving of (and consequent reduced demand for) power compared with belt driving and its associated power losses. The satisfaction of electric transport power requirements is becoming an increasing factor both for water and rail transport services. By this pooling system the tall stacks of the furnaces would become centres from which would radiate the benefits of the cheap power, and the advantages would be reciprocal. Besides removing the many smoke-stack polluters of the atmosphere, the additional profit would increase the stability of the iron industry of this country.

"The flexible demand for power which it would be the aim of the power organisation to secure would be appropriate for the intermittent periods of mill idleness, whether temporary or prolonged; for instance, the sudden release of power for external services at the week-end periods of mill idleness (or during longer periods of compulsory idleness due to the falling off or cessation of orders) would be available for one or other of these flexible power demands.

"Another and important argument in favour of the pooling policy is the fact that some 4,000 to 5,000 kilowatts of energy is the minimum demand of many of the most desirable of the electro-chemical and other operations, so that in a single works, without a drastic reorganisation of the plant, it would be impossible to secure this output of electric energy; whereas, by the pooling of the available power from several works, this power would be obtained with little change from existing conditions. Of course, the power available entirely depends upon the extent the gas engine displaces the steam engine to satisfy the internal power demands of the works.

"One of the advantages of this policy of pooling is obvious: it would not only permit such an association of power production as to justify the cost of mains to central stations, but it would provide an irresistible incentive to the thorough electrification of all the iron and steel power machinery, and justify the expenditure in securing the maximum possible efficiency of the blast-furnace gas. . . . . .

"The advantages of the pooling policy will, of course, depend upon the individual circumstances of different works. The mills are probably standing some 23 per cent. of the total hours of a week, and the power waste associated with this idle week-end period will be available. Besides, the displacement of the steam rolling and other machinery by gas and electric motors will provide power all the week, and the auxiliary gas generators can be drawn upon to balance the power required for the mills. . . . . .

"Re-capitulating the advantages of pooling, it may be said that besides facilitating the electrification of the rolling mills by the reduction in capital cost of plant, it will secure, in addition to the advantages of electrical driving, a substantial increase in the proportion of the furnace power gas available, by the suppression of the mill steam boilers. The pooling proposition will constitute an ideal combine, securing an all-round benefit to the ironmaster and the power consumer, and tend to promote the establishment of new electrical industries and thus enlarge the field of demand for power; it will financially justify expenditure in apparatus and on technical changes to secure the fullest possible economy in the use of furnace gas in the works. Of course, any available gas from associated coke oven plant, subject to certain mixing operations as will reduce the proportion of hydrocarbon in the combined gases, will be available for the pooling station. The economy resulting from the direct production of power, with a rationally devised plant, has been abundantly proved. A well-designed and built gas engine, using pure and waterless furnace gas and associated with a high-class electrical generating machine, is claimed to be able to develop the hours of a kilowatt year for 66s. 8d., assuming, of course, that no charge is made for furnace gas. This economic figure of cost to an ironmaster is unapproachable by any other system of power generation, barring water power, which is often located in such awkward if not almost inaccessible positions as to destroy the economic advantages of such power, *per se*."

THE BRITISH ENGINEERING TRADES' AGREEMENT.

AN OUTLINE OF THE NOTABLE AGREEMENT RECENTLY ENTERED INTO BY THE EMPLOYERS AND WORKMEN IN THE ENGINEERING TRADES OF GREAT BRITAIN.

Engineering.

THE following extracts from an editorial in *Engineering* on the recently signed agreement between employers and employees in the engineering trades of Great Britain give an outline of what is probably the most fair and impartial labor agreement ever entered into by any considerable organization either of employers or of workmen. The conferences which preceded the signing of the agreement were marked by an earnest desire for co-operation and a better mutual understanding and the result promises well for industrial peace in the trades directly concerned. It is anticipated that before long the example will be followed in many other trades and that it will have a permanently beneficial effect on British industries.

"Perhaps the most significant feature of the existing relations between masters and men in the engineering trades is the fact that settlements are now national, in place of local, as they were up to a few years ago. The change has, of course, resulted from the development of the Engineering Employers' Federation, which was the natural outcome of the tactics followed by the different trade unions during the decade which ended in 1898. The unions first saw the importance of a national, rather than a local, organisation, which, so long as the employers were not themselves similarly associated, conferred on them the enormous advantage of localising any dispute which might arise, the strain on their funds by a local strike being minimised by contributions from the districts where members were still at work. As a consequence, the conditions regulating the relations between employers and their workmen varied enormously from one district to another. Shop customs which were accepted by the men without demur in one locality were utterly repudiated in others, and it followed, therefore, that work of a particular character might cost substantially more in one district than in another. When the great fight on the eight-hour day question arose in 1897 the Employers' Federation determined that this state of affairs must be abolished and all districts stand on an equal footing as regards conditions of employment. This resolution was embodied in the terms of settlement agreed to in 1898, which since that date have governed the relations between the two parties in the engineering trades. That agreement, as was natural, showed some trace of the bitter warfare of the preceding months; but, in spite of that, it undoubtedly led to an improvement in the relations between the parties to it. . . . . .

"A noticeable feature of the new agreement is the omission of all direct or indirect reference to the strife of 1897. The preamble states that the representatives of the Employers' Federation on the one hand, and of the engineering trade unions on the other, being convinced that their mutual interests will be best served and their rights best maintained by a mutual agreement, have decided to adopt measures to avoid friction and stoppage of work. The first clause declares that the employers shall not interfere with the proper functions of trade unions, and that the latter shall, in their turn, not interfere with the employers in the management of their business. The terms here used are, no doubt, somewhat vague, but matters are, to a certain extent, elucidated in the succeeding clauses.

"With respect to the employment of workmen, the unions have gained a concession in terms rather than in actual fact. The employers, whilst reserving their right to employ non-unionists, now positively recommend their members not to object to employ trade unionists, whereas in the 1898 agreement they merely did 'not advise their members to object to union workmen.' They further agree that no workman shall, as a condition of employment, be called upon to state whether or not he is a society man. On the other hand, the unions reaffirm their previous recommendation to their members not to object to work with non-unionists. As now worded, this agreement as to the employment of workmen puts both sides on an identically equal footing.

"In the matter of piece-work and overtime the men have obtained more important concessions. The Federation agrees definitely that the day rate shall always be guaranteed irrespective of a man's piece-work earnings, and overtime and night-shift allowances shall be paid, in addition to the piece-work prices, at the same rates as prevail for time wages. Further, it is provided that all balances and wages shall be paid through the office. With the exception, perhaps, of the payment of balances through the office, the above conditions have long constituted the established practice in important districts, but they now become universal. Systematic overtime is deprecated, and it is agreed that no union workman shall be required to put in more than 32 hours' overtime in four weeks, exception being made in the case of break-down work, repairs, trial trips, and other urgent or emergency cases. In the old agreement the time-limit was 40 hours in place of 32, so that the men have gained a concession of 8 hours. On the other hand, the union officials have shown themselves reasonable in recognising that overtime is often unavoidable, and, indeed,

in a statement to their members, they declare that a closer examination of the subject has led all parties to realise that it is difficult to avoid special overtime in their particular trade. Here we probably have an instance of the benefit of the closer intercourse now subsisting between the unions and the employers. Unreasonable demands are most generally the outcome of ignorance. The average man is a fairly decent individual, not given to demanding the unattainable; but he, not unnaturally, desires some other evidence of the impracticability of his desires than the mere *ipse dixit* of interested parties.

"In the old agreement it was declared that there should be no limitation to the number of apprentices. In the new clause dealing with this matter the employers refuse to fix any definite proportion between journeymen and apprentices, but agree that the question of the proportion in the whole federated area shall be open for discussion. The precise meaning of this is not as clear as is desirable, but presumably gives the unions the right of calling attention to cases in which the proportion is far in excess of the general average. The employers also agree that the apprentice shall be given facilities for acquiring a practical knowledge of his trade, and shall be encouraged to obtain a theoretical knowledge thereof. Here the employers are probably taking an enlightened view of their own interests. Cases have not been uncommon in which apprentices have been far from fairly treated, and kept at one class of work for unduly prolonged periods. In the end such procedure, however immediately profitable, has proved far from satisfactory, and it was, moreover, hardly honest or honourable. An apprentice, in view of the fact that he is to be taught a trade, is paid less than he could obtain for his services in the unskilled labour market, and a fair training in his selected craft is distinctly a part and, indeed, the more important part, of the remuneration to which he is justly entitled. The recommendation that he shall, as far as possible, be encouraged to obtain theoretical knowledge is merely an official recognition of the existing practice of numbers of the best firms. Many of these definitely require their apprentices to attend evening classes, and still more offer rewards for successful work at these. It is sometimes maintained that after a hard day's work in the shops a youth is not in a fit condition to do further work in the evening. This, however, is generally the plea of outsiders who have no personal experience of the system. Physical tiredness, unless approaching absolute exhaustion, is not a bar to effective head-work, and the youth, if not at a class, is probably employing his leisure in some form of distraction at least equally exhausting, and possibly actually pernicious. The classes, moreover, generally cease during the summer months—that is to say, during the period of the year in which it may fairly be claimed that a lad shut up in the shops all day, will best spend his evenings in the open air.

"The final and, no doubt, the most important clauses of the agreement deal with the subject of avoiding future serious disputes. In the old terms of settlement it was laid down that in the first instance grievances should be brought before an employer by a deputation of his workmen, and only in case of disagreement were the union officials to be called in. The employers stated, and we believe truly, so far as the mass of them were concerned, that no workman should be victimised for forming part of such a deputation; but the fear of action of this character is undoubtedly strong amongst workmen generally, and there are, no doubt, sufficient exceptions amongst the masters to render this apprehension not entirely without substantial foundation. In the new agreement all grounds for such distrust are removed, as the workmen can at choice either deal directly with their employer by deputation, as hitherto, or through their trade-union official, without this preliminary. It is further provided that local conferences on matters in debate can be demanded by either party, such conferences to meet within twelve days of the receipt of the application by the other party. Failing settlement by this, a central conference shall be arranged as soon as possible between the executive of the Federation and the central authorities of the unions affected. No employer who refuses to employ union workmen is eligible to sit as a member of these conferences. In no case, it is provided, shall there be stop-

page of work, either partial or general, until the completion of the above procedure; but work is to proceed under current conditions. This latter provision was, of course, included in the old terms of settlement.

"It will be noted that the new arrangement, like the old, tends to increase very much the powers of the central executives of the trade unions, as compared with what they were ten years ago. In the old days strikes were undoubtedly sometimes started by ambitious and fluent, but often inexperienced, logal organisers, sometimes much against the wishes of their official superiors. It is still, no doubt, possible, for the same thing to happen, as no penalty is directly prescribed for a breach of the above conditions; but presumably such action would lead to a general lock-out, making the risks too great to be lightheartedly undertaken. In some trades, we believe, where somewhat similar agreements exist, large sums, as caution-money for the due observance of the terms, have been deposited by both parties with trustees."

ELECTRIC TRACTION ON BRITISH RAILWAYS.

A COMPARISON OF THE COST OF STEAM AND ELECTRIC OPERATION ON SOME OF THE MORE IMPORTANT ELECTRIC RAILWAYS OF GREAT BRITAIN.

Philip Dawson—Street Railway Journal.

A RECENT number of the *Street Railway Journal* contains an interesting review of the electrical equipment of main line railways in Europe by Mr. Philip Dawson, whose contributions to the literature of electric traction are well known on both sides of the Atlantic. We extract from it the following authoritative comparison of operating expenses and other results of the electrification of several British railways.

"It is practically impossible to compare directly the cost of electricity and steam per train mile and obtain anything like satisfactory results, for the reason that the introduction of electrical haulage on a suburban line will at once alter the size and type of train adopted, and in all probability lead to shorter train units being used and run at more frequent intervals than was the case with steam.

"Furthermore, whereas for suburban service there is very little difference, as far as steam locomotive costs are concerned, in hauling a train having a capacity of, say, 250 passengers, as compared with the cost of hauling a train seating, say, 700 passengers, with electricity on the multiple unit system, a unit train, say, of three cars, once adopted, would according to requirements, be made up in multiples of three and the cost per train mile for locomotive power would be practically strictly proportional to the number of units of which a train is composed. Still, it may be interesting to compare some published results on the train mile basis for steam and electricity on the same road.

"The Mersey Railway is the only one of what may be called main line systems which has been completely electrified in this connection and working for a sufficient number of years so that figures are available to warrant fairly accurate conclusions being drawn from the results obtained. It is also a good example to quote, since electricity superseded steam on a given day when the whole system was converted from steam to electric haulage. There is little use in considering the increase of traffic resulting from electrification in this case, because the line when operated by steam gave a fairly rapid and frequent service. It is a short distance traffic line, and there existed no particular reason why electricity should largely increase the traffic.

"But the financial results as regards cost of operating and the cost of locomotive power per train mile operated by steam and electricity, as well as the cost of maintenance of permanent way, fully bear out the expectation of those engineers who have made electric haulage on railways a serious study. The figures show that with the increased speed which electrification renders possible, with slightly smaller and therefore more convenient train units, the train mileage can be enormously increased without increasing the total operating costs, and that notwithstanding the very

much larger train mileage, the repairs of permanent way do not, as might be expected, increase, but are rather lower in their total annual cost than when steam is the propelling power.

"The following table affords a highly interesting comparison of steam and electric operation on the Mersey Railway for the years 1901 and 1905, respectively:

Items.	1901 with Steam.	1905 with Electricity.
Locomotive cost per train mile in pence	13.653	6.29
Train lighting and cleaning per train mile in pence	1.665	0.580
Repairs and renewals of carriages and wagons per train mile in pence	1.719	1.075
Train miles run	311,360	829,898
Total expenditure	£64,662	£69,036
Maintenance of permanent way	£6,055	£3,793

"The total gross receipts for the half year ending June 30, 1901, were £38,327, while those for the half year ending June 30, 1906, were £47,129, or an increase of 23 per cent.

"Another comparison of Mersey figures is between the year 1901, operated by steam, and the year 1906, operated by electricity, which entirely confirms the figures given in the previous table; thus, in 1901 the total expenditure, including everything, was £64,662, the train mileage being 311,360 train miles; in 1906 the total expenditure, including everything, was £70,930 and the train mileage 829,188 train miles. It will thus be seen that an increase in train mileage of 167 per cent. increased the total expenditure by only 10 per cent.

"In comparing the cost per train mile of steam and electricity it must be borne in mind that steam trains were, on the average, composed of seven cars, having a capacity of 350 passengers. Now, when operated by electricity, according to the time of day, the number of cars per train varies from two to five, and the average seating capacity of an electric can be taken as 55 passengers, as compared to the average seating capacity of steam cars of just under 50 passengers.

"These figures clearly demonstrate the great benefit which railways will get by electrification of their suburban systems. It shows that they will, owing to the high rate of acceleration, be able to greatly increase the average speed, and therefore the number of trains, and thus to utilize better the existing facilities, both as regards tracks and termini. Consequently they will largely augment their earning capacity without increasing their present total working expenses. And as Mr. Aspinall (the general manager of the Lancashire & Yorkshire Railway) has always maintained, the object of electrification is not so much to decrease the expenditure of a railway company as to increase its earning power. Nothing but a greatly accelerated and more frequent service can enable them to hold their own, and it is only electric traction that will provide this acceleration. That frequent and rapid service does, in most cases, provide an efficient remedy is clearly shown by the satisfactory results obtained both in the case of the Lancashire & Yorkshire Railway and of the North Eastern Railway. The latter is a particularly good example, because the electric lines between Newcastle and Tynemouth suffer from the most acute tramway competition. Notwithstanding this fact, the profits are considerably greater now on this railway than they were in the days before there existed any electric tramway competition. This is clearly shown in the following table:

Items.	Half Year Ending 1903. Steam Operation.	Half Year Ending 1905. Electric Operation.	Percentage of Increase.
Gross earnings	£129,000	£151,000	17.1
Running costs	£42,761	£47,779	11.7
Ratio of costs to receipts	33.2%	31.8%	....
Loco. costs per train mile	14.5d.	6.75d.	....
Passengers carried	2,844,000	3,548,000	24.8

"In reading the above table it must be borne in mind that the figures given as running costs for steam operation, are, if anything, too low. An exact figure is unobtainable owing to the difficulty of differentiating between the costs for local service and the total locomotive costs for the whole service. But even on the supposition that the comparison is a fair one, it affords a most satisfactory proof of the advantages to be obtained from electrification, particularly in view of the fact that electric tramway competition has very largely increased of late, which shows that the electrification of the railway has not only enabled it to hold its own but also to increase its traffic.

"Having thus considered the actual results as regards working expenses which are obtainable and authenticated, it may be

interesting to study some figures specially compiled for London conditions and in which an attempt has been made to compare on a similar basis the cost of operating a service under similar conditions.

Items.	STEAM—Cost per train mile, 7-car train, with seating capacity of 520 passengers.	ELECTRIC—Cost per train mile, 3-car train with capacity of 210 passengers in London.
Fuel or current	6.96d.	5.00d.
Water, oil, waste and stores	0.90d.	0.90d.
Maintenance and repairs	3.41d.	0.85d.
Wages	3.25d.	1.58d.
Lighting	0.85d.	included in current

Ratio of locomotive costs of electricity to steam 48.5 per cent (including current and capital charges on conduction and distributing system).

"From the above table it will be seen that on the train mile basis the locomotive costs for electric traction, maintenance and capital charges in electrical distribution included, are less than half the cost per train mile if operated by steam. Against this, however, would have to be placed the fact that the capacity of the steam train is more than double that of the electric train under consideration. But there is the additional important consideration that the costs given for electric service are for an average acceleration more than double that obtained with steam, and consequently that the average speed of traveling with the electric train is nearly double the maximum that the local steam trains, with present stops, can attain.

"It must be borne in mind that it would be impossible with steam haulage to increase effectually the speed of these local trains. To make a fair comparison, one must take as the average speed for electric trains the same speed as that of the present steam trains. On that basis the same number and power of motors that are required to drive the three-car train as given in the previous table, would be amply sufficient to operate a seven-car train, and if the trailer and rolling stock were the same as that at present in use with steam haulage, the carrying capacity of the train should easily equal that of the present steam trains. The table previously given would then very closely represent the comparative cost of operating by steam and electricity under the same conditions.

"From this it will be seen that, when compared on the same basis, the cost of hauling suburban trains by means of electricity is less than half that of operating by steam, with the additional advantage already cited thrown in, of the saving of time effected at termini, owing to the use of motor cars and multiple unit control.

"There remains another and most important factor to take into consideration, and that is the better use of the seating capacity per hour if run by smaller and more frequent trains instead of fewer and more capacious trains."

MUNICIPAL OWNERSHIP OF PUBLIC UTILITIES.

A COMPARISON OF THE COST OF STEAM POWER IN MUNICIPAL AND PRIVATELY-OPERATED PLANTS.

John W. Hill—Central States Water-Works Association.

ONE of Mr. Judson H. Boughton's tables in the November number of THE ENGINEERING MAGAZINE showed the average cost of street lighting to be much less under private contract than under municipal ownership of electric-power plants. Mr. Boughton remarked that while municipal plants have in some few instances showed satisfactory results for a time, they have eventually fallen, through political changes, under the disastrous management of incompetents. That this is bound to happen in the management by a municipality of almost any public utility is held by Mr. John W. Hill in a recent address before the Central States Water-Works Association. Taking the operation of steam-power plants in municipal water-works and in private enterprises as a particular example, he gives the following interesting comparison of costs.

"During the past few months I have had occasion to collect statistics on the cost of steam power, and in support of the claim of better management by private corporations, advanced in this paper, it is found that even in the few cities having the highest type of triple-expansion pumping engines, and accessories to match, and in which the contract test and annual duties of the machinery are the best ever attained, the cost of power per year is great-

er than in the large well-managed steam power plants, owned and operated by the private electric and manufacturing corporations, and a comparison of statistics divided as to cost of fuel, labor, repairs and stores, show the excess cost to be principally in the item of labor.

"In the following table, the figures represent the annual costs per indicated horse-power of prime movers: Coal figured at $2.50 per ton, excepting Hamilton, $2.20 per ton. City Water-Works, and Philadelphia Power, 8,760 hours; Pittsburg Power, 8,666 hours; Hamilton, 8,000 hours.

Nature of power.		Fuel.	Labor.	Repairs.	Supplies.	Total.
City pumping works ...	(1)	$15.70	$24.62	$5.96	$2.74	$49.02
"	(2)	17.44	25.19	5.25	2.58	51.48
"	(3)	16.70	24.01	1.28	2.05	44.04
"	(4)	16.75	21.90	1.85	1.88	42.38
"	(5)	16.82	26.19	1.17	1.59	45.77
"	(6)	21.39	15.64	9.62	1.24	47.90
"	(7)	18.89	....	4.14	...	50.03
"	(8)	27.64	26.44	9.55	5.44	69.08
New York..	(9)	25.55	13.13	5.90	1.42	46.00
Philadelphia	(10)	20.51	6.61	1.52	1.32	29.96
Pittsburg ...	(11)	19.51	4.42	3.55	2.50	29.97
Hamilton ..	(12)	16.90	5.18	0.88	0.64	23.62

"It is interesting to note that the total cost of power by a private corporation, No. 12 on the list, is less than the cost of labor alone in the city water-works power, Nos. 1, 2, 3, 5, and 8. The figures are from the last annual reports. The costs of labor, repairs, and supplies are not known in detail for No. 7, but can roughly be stated as $25 for labor, $4.14 for repairs and $2 for supplies.

"In each city pumping station, the engines considered are from the best known and highest class builders, and the water-works profession is accustomed to point to the cities considered as examples of excellent water-works management.

"The average cost of labor in the eight city power stations is $23.62 per indicated horse-power per year for 8,760 hours, while the average cost of labor in the private corporation stations is $7.33, or about one-third the cost in the municipally-owned and operated stations, or to state the matter in different form, the city uses three men to do one man's work.

"Engineers generally recognize the modern high duty triple-expansion pumping engine as the highest type of steam power, and the service of pumping at constant speed, against a steady head, to reservoirs, the 'optimum' condition for high running duty. Moreover, the long runs of pumping engines, without interruption for Sundays are calculated to favor the annual economy, when compared with steam engines working under a constantly varying load, and, in all but traction and electric lighting stations, stopped altogether for Sundays and holidays.

"The duties obtained on the trials of Engines 1 to 6, inclusive, are the highest in the history of pumping machinery, a fact well attested by the annual charge for fuel; indeed the fuel costs, on the average, are as good for the city-managed works, as for the private-managed works. But when you come to the labor charge, there is where the politician comes to the front in great shape. There could be no political advantage in being wasteful of fuel, but there is a decided advantage in future elections in being wasteful of labor. Two men can cast two ballots, and three can do better, while the coal burned in the furnace cannot vote, and there is therefore no advantage in being prodigal with it.

"After allowing for the favorable conditions of modern water-works steam pumping service, even then the cost of power in the best private works is less than in the best water-works under municipal management.

"Instances can be multiplied of power costs under municipal and private control which will verify the low cost for labor for private control and the high cost for municipal control. And if compared on the volume of business transacted, it can be demonstrated in almost any if not all cities that the cost per unit of work performed or business conducted is much greater for public than for private business.

"The least objectionable of public works which can be conducted by the public are the building and maintenance of sewers and sewage disposal works, the cleaning of streets and the collection and disposal of garbage, although in some large cities this work is now the subject of annual contract. Water-works, electric and gas works, trolley lines, and steam and hot water heating systems, works employing large numbers of people, and requiring skilled assistance, should be the subject of private construction and control under contract or franchise which will properly safe-

guard the interests of the public and prevent extortion or poor service.

"Cities have been and can be robbed by public service corporations, but only with the aid and connivance of public officials. Standing alone, the public service corporations will be compelled to meet the obligations imposed on them by their franchises, and give the public the required service at fair rates. The legislature can pass laws and the city councils can pass ordinances giving away public rights, and the public service corporations may be the beneficiaries thereby, but the officials chosen by the people to represent them are the culpable parties in such transactions."

RAILROAD REGULATION AND POLITICS.

A DISCUSSION OF THE POLITICAL ASPECT OF THE AGITATION FOR FURTHER GOVERNMENT CONTROL OF THE RAILROADS OF THE UNITED STATES.

Walker D. Hines—Traffic Club of New York.

TO the impartial student of national questions it must be apparent that the present anti-railroad agitation has long since passed from an honest endeavor to safeguard the public interest and has developed into a general attack, promoted and fostered for political purposes. An impressive exposition of this fact is contained in an address recently delivered by Mr. Walker D. Hines, general counsel for the Santa Fe, before the Traffic Club of New York, from which the following extracts are taken.

"The interstate commerce act as now amended regulates in a thorough-going way the relations between railroad companies and shippers, prohibits unjust discriminations and preferences and all unreasonable rates and in all respects enjoins the utmost publicity. The commission is given power to enforce all these regulations and is given practically unlimited power to inquire into the affairs of the railroad companies. Most of the states have similar laws and commissions with similar powers. In addition there are numerous laws, both federal and state, regulating the equipment of railroad companies and their relations with their employes. In matters of train schedules, speed, etc., the railroad companies are subject to numerous local regulations. In matters of taxation railroad companies are subject to exceptional burdens. In addition, railroad companies are subject to especially strict liabilities which are being constantly and rigorously enforced by the courts.

"Under such conditions there is no serious wrong which a railroad company can do that is not susceptible of substantial correction, and generally such correction can be accomplished by public officers without expense to the individual. Therefore, it would seem that all the railroad situation requires is for the public authorities to enforce the numerous laws already in effect. Strange to say, however, the principal talk is about further railroad regulation. Strangers to the fact would assume that railroads are free from any substantial public control and are in an exceptionally lawless attitude, and that the paramount necessity is for the inauguration of an original policy of public control. What is the explanation of this anomalous condition? Why is it that the most strictly regulated enterprise in the land is singled out for so much additional legislative restriction?

"We find the explanation in the fact that railroad regulation is the political field most easily cultivated and most fruitful in results to the politician. It is human nature to be distrustful and critical with respect to great wealth, and this distrustful and critical sentiment has generally settled especially upon the railroad, for that is the thing which the people see and with which they deal to a much greater extent than with any other form of capital. In every community the railroad is the most tangible and obvious form of accumulated wealth. The champion of the people who wishes to pose as St. George and slay the dragon for the pretended protection of the people finds that the railroad furnishes the most visible and striking material out of which that dragon may be constructed. Coupled with this availability of the railroads to political exploitation is the further fact that the advantages of such po-

litical exploits are merely temporary. Such political advantage is a commodity which is consumed in the using. The politician who scores by securing railroad regulation feels that to continue his success he must score again by securing still further railroad regulation. The other politicians not identified with the railroad regulation obtained feel that they must find other ways to score in the same game so as to restore their prestige. Consequently it is more strictly true of railroad regulation than of any other form of legislation that generally speaking every act of legislation stimulates its author to additional activity and inspires his rivals and imitators with the highest competitive zeal. Competition is said to be the life of trade, but competition among the politicians is proving almost the death of the railroad trade.

"One of the arguments for the Hepburn bill was that that bill merely conferred upon the interstate commerce commission the same powers that were already exercised by state commissions. Yet the mere fact that congress thus adopted the policy of the states inspired those states to go much further and to seek to devise all sorts of additional anti-railroad policies. The local statesmen, seeing the political advantages which accrued to national leaders by reason of the Hepburn act, straightway sought to secure corresponding advantages to themselves by devising new forms of local regulation.

"But the agitation has not been confined to the states. The clamor for additional national legislation is greater than it was before the Hepburn act was passed. The passage of that act was urged because it was said rates were extortionate. Now it is claimed that it is impossible to tell whether rates are extortionate or not until further legislation can be had which shall regulate the capitalization and the valuation of the railroads.

"Another striking illustration of the political competition in the matter of railroad regulation is shown by the unwillingness of governors and legislators to leave to the state commissions the administration of the subjects within the jurisdiction of the commissions. Apparently there is fear in some quarters that the commissioners might get political credit which others are anxious to appropriate. Thus we find in states where the commissions have ample power to reduce rates and have the machinery for making thorough investigation to ascertain whether rate reductions are proper that the legislators with the approval of the governors rush in to make reductions on their own account and without investigation. Governor Hughes' veto of the 2-cent rate bill in New York was a striking exception which proved the rule.

"Another prominent indication that this agitation has now reached a peculiarly political stage is shown in the character of legislation regulation and notably in the case of reductions in passenger rates. Passenger travel is a luxury to a much greater extent than is the transportation of freight. It is absolutely necessary for people to have fuel and food and clothing, but it is rarely absolutely necessary for people to travel. Therefore, from the public standpoint, passenger rate reduction is even more unimportant than are freight rate reductions. Passenger business is far less profitable to the railroads than is the freight business. Therefore, from the railroad standpoint, passenger rate reduction is much more unjust than freight rate reduction. Yet, although passenger rate reduction is, from any point of view, the least justifiable form of rate reduction, it is the form which has proved most popular with legislatures. The only explanation is that the legislators appreciate that a reduction in passenger rates is more obvious to the voter and therefore has more political advantage. Another form of legislation which has been exceedingly popular is legislation at the instance of or for the benefit of organized labor, where again the appeal could be made in the most tangible form to the voter."

A state of political competition for anti-railroad legislation has been reached in which every possible means is being taken to create worse feeling and to prevent co-operation between the railroads and the public. For several years the railroads have been struggling to handle a traffic which has increased much more rapidly than their facilities could be extended, and, considering the relative difficulties, have attained a degree of efficiency higher than

has been realized in any other industrial enterprise. But in the present anti-railroad agitation no credit is given the railroads for what they have accomplished; on the contrary, every minor deficiency is seized upon and utilized to excite hostile feeling. The public has been talked into an extremely hysterical frame of mind by the large numbers of active and intelligent politicians who are devoting a great part of their time to furnishing the suggestion necessary to fire the public imagination and to intensify and magnify any germs of railroad evils which may exist.

"I do not, of course, mean to say that all railroad laws have attained a condition where they are not susceptible of improvement from the public standpoint. I do contend, however, that at the present time railroad laws are so far reaching as adequately to cover all substantial evils, and that the public has been brought to such a state of mind, and the politicians have developed such an enthusiastic rivalry that any further legislation, even though theoretically wise, when considered in itself, will cause a vast amount of harm by stimulating further imitative and competitive activity on the part of politicians in general, and at the same time would add little if anything to practical safeguards which the public already enjoys.

"In a word, I say to each of you as good citizens, and in the public interest fully as much as in the railroad interest, do your best to discourage the professional maker of anti-railroad laws, and do your best to encourage the administrator of the laws already made, to study the facts thoroughly and then enforce the laws accordingly. What the public needs is less anti-railroad talk and less anti-railroad tinkering and a fair investigation of the facts and intelligent enforcement of existing laws."

A TIDAL-POWER AIR-COMPRESSING PLANT.

DETAILS OF THE DESIGN OF A PLANT FOR COMPRESSING AIR BY TIDAL POWER TO BE ERECTED AT SOUTH THOMASTON, MAINE.

William O. Webber—The Engineer.

SOME months ago a review in these columns gave the general features of the problem of compressing air by tidal power with reference to a project for the erection of a large plant at South Thomaston on the Maine coast. Recently more detailed information of the design adopted has been communicated to *The Engineer* by Mr. Wm. O. Webber, the author of the former paper, from which the following extracts are taken.

Diagrams are shown, giving the details of the lock and inlet and outlet gates, a general plan and sections of the complete construction at the same point, and a profile of the location at South Thomaston. "At this point the maximum tide is 10.6, mean tide 9.4 and minimum tide 7.9 feet, giving, respectively, 5,000, 4,000 and 3,000 horse-power.

"In the dam, where the main channel is navigable, will be a lock for vessels, 40 feet wide, 200 feet long, and 28 feet deep. On either side of this lock will be one or more sets of shafts, each making a unit, or compressor, of 1,000 or more horsepower. These shafts will be sunk into the rock to a depth of 203.5 feet below mean low water, the down-flow shaft being 15.75 feet in diameter, and the up-flow shaft 35.65 feet in diameter. The in-flow gates will be five in number and 10 feet wide, the out-flow gates six in number and 10 feet 8 inches wide.

"The water on entering the inflow gates will swing them open, pass down the down-flow shaft at a velocity of 16 feet per second, drawing in air through about 1,500 half-inch inlet tubes. Arriving at the bottom of the shaft, the combined air and water will flow in both directions horizontally, the air separating from the water until all of the air is accumulated in the separating chambers. The water will then flow up the up-take shaft at a velocity of three feet per second, and out through the out-flow gates.

"The air entrapped in the air chamber is then under a head of water 195.5 feet high, varying with the height of the tides. This compressed air is then led up the up-flow shaft in a 14-inch pipe. At the top of the gates these 14-inch pipes are united into a

30-inch pipe, which conveys the air ashore.

"The air thus compressed will contain about one-sixth the moisture that is in the atmosphere from which the air is drawn, owing to the absorption of the moisture in the compressed air by the surrounding water. The dryness of this air makes it particularly adaptable for transmission to considerable distance, in pipes, without undue friction. For instance, the whole 5,000 horsepower could be transmitted a distance of 1 mile, in 30-inch pipe, with a loss of only 1.5 pounds pressure, or 10 miles, in a 48-inch pipe, with only a loss of 2.5 pounds pressure.

"This air can be used cold, without danger of freezing in expanding, in steam engines or rock drills. A test was made on an 80-horsepower Corliss engine, in which the entering air was 5.3 degrees F., and the exhaust minus 40 degrees, and continued for 10 hours without the slightest sign of frost in the exhaust passages and pipes of the engines. A marked economy, however, is obtained by preheating this air immediately before using it in motors, as raising the air to 370 degrees will practically double the volume of the air, and, instead of requiring 3 to 4 pounds of coal per horsepower per hour, as air receives heat about six times as easily as water, these results can be obtained at an expenditure of from ½ to ⅝ pound of coal per horsepower per hour.

"As there are no working parts in the compressor, there is no depreciation, or operating expenses, to be taken into account, excepting watchman to prevent depredations on the plant, keep ice and floating timbers from permanently obstructing the inlet racks, and operate the boat lock. Therefore the cost per horsepower is practically represented by the interest on the original investment and the wages of these watchmen. The cost of original construction will amount to about $100 per horsepower.

"There are numerous places, all practically situated between the 40th and 50th parallels of latitude, in both the northern and southern hemispheres, where the tides are of sufficient magnitude to make this plan commercially feasible, the necessary requirement being a tidal basin, of considerable size, connected with the ocean by a comparatively narrow outlet. Each acre of such basin, under a 9-foot tide, is capable of producing 5 horsepower. It is not commercially feasible to develop such a plant with a basin containing much less than 200 acres, or requiring a length of dam exceeding 3 feet per acre of pondage."

HIGH PRESSURE TURBO-COMPRESSORS.

A DISCUSSION OF THE ADVANTAGES OF THE RATEAU CENTRIFUGAL COMPRESSOR WITH A DESCRIPTION OF TYPICAL INSTALLATIONS.

A. Rateau—Revue de Métallurgie.

IN his article on exhaust steam turbines in the November number of THE ENGINEERING MAGAZINE, Dr. Gradenwitz mentioned in passing the high-pressure turbo-compressors developed by M. A. Rateau of Paris, whose work on low-pressure steam turbines has met with such a degree of success. The following details of the advantages of turbo-compressor operation are taken from a paper by the inventor in a recent number of the *Revue de Métallurgie.*

The turbo-compressors are exactly analogous to the centrifugal pumps devised by M. Rateau, with the addition of a device for cooling the air. In the first turbo-compressors cooling was accomplished by a device similar to a surface condensing plant placed between each pair of successive compressor units. Recently, however, a more satisfactory system has been devised in which fresh water is introduced into the partitions and the diffuser vanes. The effect of this large increase in the cooling surface has been to reduce greatly the heating of the air and the compression is accomplished even closer to the isothermic cycle than is the case with reciprocating compressors. Efficiency tests conducted by M. Rateau on several recently-constructed machines indicate that very high pressures can be attained with an efficiency of 60 to 63 per cent., which is very near the result obtained in the best reciprocating compres-

sor practice and it is probable that this will be improved upon.

Besides having an efficiency about equivalent to that of reciprocating compressors, the turbo-compressor possesses several peculiar advantages. One of the most important of these lies in the fact that for units of equal power the advantage in space is largely on the side of the turbo-compressor. M. Rateau instances the case of the Commentry steel works where a blowing engine occupying 164 square metres of floor space was replaced by a turbo-compressor of the same power taking up an area of 7 square metres. Besides the saving in foundations and space, the almost entire absence of vibration was a notable result of the installation of the centrifugal compressor.

On account of their smaller size and comparative simplicity of design turbo-compressors are relatively cheap when compared with reciprocating compressors. Further, their working expenses are much lower; there are no complicated parts to get out of order and the consumption of lubricating oil is very small, since the bearings of the shaft are the only parts subject to friction.

The air current yielded by turbo-compressors is perfectly regular and there are none of the pulsations which necessitate the installation of compensating reservoirs when reciprocating machines are used. The output may be regulated readily within wide limits by slightly varying the speed or by opening or closing a gate in the suction or compression conduits, but in spite of this elasticity, a constant output at a constant pressure can be maintained.

The possibility of coupling turbo-compressors directly to electric motors and steam turbines without any intermediary gearing is of great advantage on account of the lowering of friction losses in this method of driving. As mentioned by Dr. Gradenwitz last month, the exhaust steam from engines, operating low-pressure Rateau turbines can thus be utilized for the production of compressed air. This feature is of especial value in mining plants and metallurgical works, where compressed air can be produced by means of the exhaust steam from the winding engines and rolling-mill engines respectively, with the aid of a steam accumulator. In this special field, the utilization of exhaust steam for compressing air, the reciprocating compressor obviously cannot compete with the centrifugal type.

M. Rateau gives several examples of turbo-compressor plants now in operation in Europe. Many plants for the compression of air by the utilization of exhaust steam are in course of construction, modeled after the pioneer plant at the Béthune mines. In this installation the exhaust steam from the winding engine is used to compress air up to six or even seven atmospheres. The plant which has been in regular operation since May, 1906, consists of four multicellular ventilator units traversed by the air in series. These units are arranged in groups of two each on two parallel shafts, each of which is driven by a low-pressure turbine. A high-pressure turbine fitted to one of the shafts is idle under normal conditions and is used only as a reserve in the case of interruption of the exhaust steam supply. When such an interruption occurs an automatic apparatus opens the entrance conduit of the boiler steam to the high-pressure turbine, the exhaust of which is conveyed to the low-pressure turbines. Another automatic device distributes the load uniformly between the two shafts. Between each two consecutive compressor units are cooling devices to which cold water is supplied by a small centrifugal pump mounted on the same shaft. Running at 5,000 revolutions per minute, this plant yields 900 litres of air per second at a pressure of 7.13 kilograms per square centimetre above atmosphere, the highest pressure yet reached by turbo-compressors. The efficiency of the first three units is as high as 70 per cent.

A turbo-compressor at the Chasse blast furnaces yields 7.2 cubic metres of air per second (atmospheric pressure) at a pressure of 30 centimetres of mercury. The plant is so designed that in the event of any irregularity in the working of the blast furnaces it is capable of yielding four cubic metres per second at a pressure of 60 centimetres of mercury. This feature is attained by dividing the compressor into two identical units which may be coupled up either in parallel or in series. The speed of rotation is 3,000 revolutions per minute.

THE UTILIZATION OF PEAT.

A REVIEW OF RECENT ADVANCES IN THE USE OF PEAT IN THE GAS PRODUCER FOR POWER GENERATION WITH RECOVERY OF BY-PRODUCTS.

Electrochemical and Metallurgical Industry.

THE development of the gas producer and gas engine has to a great extent changed the problem of the utilization of peat. In the old problem the object was to convert the peat into a satisfactory fuel for domestic purposes and for use in the boiler furnace, and to produce the latter at such a price that it could be shipped to industrial centres and compete with coal. A later problem aimed at the utilization of peat in by-product coke ovens, but within recent years the most satisfactory method of setting free the vast amounts of energy stored up in the peat bogs of the world has been shown to be the use of peat in the gas producer for power generation, with recovery of by-products. An interesting description of the results which have been attained, based on lectures by the German investigators, Drs. Frank and Caro, who have been largely responsible for the development of the process, is given in a recent number of *Electrochemical and Metallurgical Industry.*

The composition of peat varies greatly in respect to its content of water, ash, nitrogen, etc., but the purely organic substance has the fairly uniform composition of carbon, 60 per cent., hydrogen, 5 per cent., and oxygen, 35 per cent. The water and ash are, of course, deleterious elements, the nitrogen may be used for the production of useful nitrogen compounds, but the carbon and hydrogen content represents a large amount of stored-up energy, since both of these elements when oxidized set free considerable quantities of heat.

The difficulties in recovering this energy are due to both the composition and structure of the peat. Normally peat contains, when first cut, 80 to 90 per cent. of water, a large part of which must be removed before the peat is of any value as fuel. Natural drying takes a long time and produces a fuel with little heat value per unit of volume, while attempts to press the water out mechanically have proved unsuccessful owing to the peculiar structure of the substance. Better results have been obtained by crushing, kneading, and mixing the peat and then compressing it into quick drying blocks of "machine peat," but it must be recognized that peat is an inferior fuel and cannot compete with coal except under very exceptional circumstances.

Machine peat when quite pure and low in ash can be used with some success in by-product coke ovens for the production of coke, with recovery of acetic acid and ammoniacal liquor, but such undertakings could be financially successful in only a very limited number of places and under only the most favorable circumstances.

"The processes which we have considered so far relate to the application of peat as fuel, either in the form of peat fuel or peat-coke fuel. In any case, it is important first to dry and compress the peat for these purposes down to somewhat like 20 per cent. of water. Further, if one wants to produce good peat coke, one is restricted to the use of peat low in ash as raw material. Such processes may be profitable at certain places under local conditions, but they do not represent the solution of the general peat problem.

"Prof. Frank attempts this solution in another way. Instead of trying to subject peat to a treatment that would make it available for shipment to industrial centers, he says we must endeavor to bring industry and commerce into the peat deposit districts. Peat areas should be considered just like waterfalls, as centers of stored-up energy. In his first paper (1897) Frank considered the erection of large generating stations in the peat districts with reciprocating engines, the peat being used as fuel under boilers. But even in those early days Frank considered that it might be possible to gasify the peat in gas producers and use the gas directly in gas engines. This idea was taken up more strongly in his second paper (1903), since the large gas engine operated by producer gas, blast-furnace

gases and coke-oven gases had made its appearance in the meantime in the industry. In this paper he estimates that in a gas-engine plant it is possible to produce about twice the amount of power which can be produced from the same amount of peat in a steam-engine plant.

"In this paper (1903) it is also mentioned that the generation of a suitable producer gas from lignite and peat has been proven practical, that lignite gas engines are operating at the Mansfeld Gewerkschaft, near Eisleben, and on the Sophien mine, near Meuselwitz, and that peat gas engines have been built by the Deutz Gas Engine Co., by Körting Bros., by Julius Pintsch, by the Oberursel Machine Co., and others. The Deutz Gas Engine Co. reported that when using air-dried peat, containing 16.57 per cent. water, 1 horse-power-hour requires 1.27 kilogram of peat, while according to a later statement the same company has succeeded in reducing the quantity of peat required for 1 horse-power-hour to 0.85 or 0.9 kilogram.

"But what is still more important, it is by no means necessary in such processes to dry the peat to such an extent that it contains only somewhat like 20 per cent. of water. It is quite possible to gasify peat containing 50 to 55 per cent. of water. Moreover, in this process, it is possible to recover almost the total nitrogen contained in the peat in form of ammonia.

"In the dry distillation of peat only a small amount of the nitrogen is changed into ammonia, as is proven by the fact that peat coke thus produced contains considerable amounts of nitrogen; as an example the following analysis of peat-coke is given by Caro: 86.41 per cent. C, 1.57 H, 1.26 N, 7.09 O, 3.67 ash.

"On the basis of the well-known Mond process, Dr. Caro has worked out a new method for gasifying peat in a mixture of air and overheated steam in excess. This process has been tried with Irish peat on the Mond works in Stockton, and it has been found that almost the total amount of nitrogen in the peat is changed into ammonium sulphate, which can be easily sold as fertilizer.

"At the Stockton works the output from 100-kilogram peat, calculated as free from water and containing somewhat more than 1 per cent. nitrogen, was 2.8 kilograms ammonium sulphate and 250 cubic meters of producer gas with a calorific value of 1,300 calories.

"Dr. Caro gives the following results obtained in tests in Winnington, England, where there is a large Mond gas producer plant. The Mond gas producers which were available there were partly used for gasifying peat. The peat gas was supplied to the gas engines which were otherwise operated with Mond gas, and ammonium sulphate was recovered in the same works.

"The engineer in charge of the gas engine plant did not know whether he received Mond gas or peat gas, because all gas came through the same supply mains. He did not even find the difference in the operation of the gas engines.

"Six hundred and fifty tons of peat were gasified in the whole. The composition of the peat substance, assumed free from water, was ash 15.2 per cent., volatile substances 43.8 per cent., nitrogen 1.62, total carbon 56.3, fixed carbon 34.2, with a calorific value of 5,620 large calories. The peat was used in different conditions, mostly with an average content of 40 per cent. water, and 1,780 cubic meters of gas with a calorific value of 1,360 large calories were obtained per ton of water-free peat substance. Besides this there were obtained 118 British pounds, 55 kilograms, ammonium sulphate per ton of water-free peat. I state again that this was not ammonia gas, but real salt which was weighed.

"The gas was partly used for generating the steam required for the gas producer process, partly for heating the ammonium sulphate solution, and besides this an excess of gas was obtained, namely, for each ton of water-free peat, gas was obtained giving 480 horse-power-hours in gas engines.

"In this plant the cost of the treatment of 100 tons of peat (the weight being calculated on the basis of water-free peat) was $50, including wages ($1 to $1.25 per man per day), repairs, etc. Further, for the production of the ammonium sulphate, sulphuric acid, costing $41.25 (at $7.50 per ton), was used. Finally, if the amortization is taken as $33.75 (at 10 per cent.), the total cost is $125. On the other hand, from these 100 tons of water-free peat am-

monium sulphate in the amount of about $325 was obtained. This shows a good profit, especially if it is considered that the gas is supplied to the gas engines in absolutely pure condition.

"It has been found that the segregation of dust particles in a gas which has been freed from ammonia, takes place with much greater speed and intensity than in peat gas containing tar. One cubic meter of gas contained only 0.16 gram of tar, and the gas engines operated with this gas very well and without trouble. The content of hydrogen in the gas does not vary more than ½ of 1 per cent. in the maximum.

"The cost of the 480 horse-power-hours produced was, of course, very low. If we do not take into account the profit from the ammonium sulphate the cost of the electric horse-power-hour was less than 0.125 cent.

"Finally, peat gas produced in this way is not only suitable for generation of power, but may be used for all kinds of heating purposes if proper furnaces are employed. Its use in steel works recommends itself, since it is absolutely free from sulphur."

THE TESTING OF WINDING ROPES.

RECOMMENDATIONS FROM THE REPORT OF THE TRANSVAAL COMMISSION ON THE USE OF WINDING ROPES IN MINE SHAFTS.

Iron and Coal Trades Review.

THE Commission appointed by the Lieutenant-Governor of the Transvaal in 1905 to inquire into the use of winding ropes, etc., in mine shafts has recently issued its report. The following extracts, taken from the *Iron and Coal Trades Review*, give the recommendations of the Commission with regard to the testing of winding ropes both before installation and during service.

"In dealing with the important matter of how best to ascertain the true strength of a new rope, the weight of evidence is in favour of a tensile test to destruction of a sample of the whole rope. It is true that some manufacturers state that the true breaking load can be calculated from the aggregate strength of the wires, but there still exists a considerable diversity of opinion amongst these experts as to the percentage reduction that should be made from this total to take account of the fact that the wires, when laid up in the form of rope, are not in a position to give out their full efficiency. One manufacturer advises a deduction of 8½ per cent. whilst others state 10 per cent. to 12 per cent. There is also a lack of agreement as to whether or not these deductions should vary according to the construction of the rope. As a practical acknowledgment of the inaccuracy of these assessments for use generally, it is found that the majority of the manufacturers, who export ropes to the Transvaal prefer to give the strength of the rope as the aggregate of the strength of its wires, and allow the purchaser to make any deduction he may think proper.

"Mr. Epton, after a large number of tests of new ropes of various manufacture and construction, found that a difference of from 3 to 16 per cent. existed between the aggregate strength of the wires and the breaking load of the rope. Thinking that this loss of efficiency might disappear after the rope had been well tightened in the course of a few weeks' use, some further tests were made under these conditions. The results point to the fact that this efficiency is not regained. Seeing that it is highly desirable in the interests of safety that the real breaking load of a new rope should be known in preference to the theoretical ultimate strength, the Commission is led to the conclusion that the only correct method is to test a whole sample of each new rope before it is put into use; that is to say, each new rope should be delivered to the purchaser accompanied by a test certificate, which, if not obtained in the country of origin, should be procured from the Government Testing House in the Transvaal, duplicates being allowed for separate portions of the same coil.

"As to the length of rope required for such a test, opinions vary, some witnesses saying that a length of 2 feet is sufficient, while others consider that it is necessary

to use at least 10 feet, but from experiments made in the Transvaal Mines Department Mechanical Laboratory, very little difference appears to exist even in these limiting cases. The results of comparative tests between long and short samples of two ordinary winding ropes are made public by Mr. Epton. In one case there was practically no difference, and in the other case, in which a length of 4 feet 4 inches was compared with a length of 14 feet 10 inches, a difference of 900 pounds in 50 tons was found, this being in favour of the short test length. Several different methods of holding the whole rope specimen during test appear to be in vogue, but the best and most frequently used in public test houses is to open out, clean and tin the wires, and then run on a soft white-metal conical seal. In the Mines Department Laboratory it is the practice to use an ordinary commercial white-metal which has a melting point of about 375 degrees Fahrenheit, and has been found not to damage the wires in the least degree. It is considered a proper practice to apply to the individual wires of a rope other standard tests, such as tension, torsion, and bending tests. These are very useful to mark down a very inferior wire, or to show up large departures from uniformity. To determine the strength of a winding rope during its working life, the evidence taken appears to show that the best method is to re-cap the rope at intervals of from three to six months, and to have a portion of the rope cut off for testing purposes. It is also strongly advised to thoroughly examine the wires at the same time for corrosion or any other deteriorating influence by means of a magnifying glass or microscope. It would be more correct to make the interval between successive 're-cappings' dependent on the 'duty' of the rope, but this course is obviously impracticable. The Mining Regulations of the Transvaal provide for regular re-capping, not more than six months being allowed to elapse between successive re-cappings in the case of a round rope, and three months in the case of a flat rope. A portion of the rope cut off in length not less than half the circumference of the pit-head sheave, must be sent to the Government Mechanical Laboratory for testing. The practice followed in the Laboratory is to furnish a certificate of the actual breaking load of the specimen, and at the same time to call the attention of the mine manager to any defects, such as brittleness, corrosion, want of lubrication, etc. This practice is in every way commendable, but we would recommend that the six months' period should apply also to flat ropes, which are no more difficult to examine than round ropes.

"With reference to the utility of an elongation test of the whole rope, from time to time, during its working life, opinions seem to be about equally divided on this point. Some witnesses think it would be an advantage at stated intervals to ascertain the stretching power of the rope when hanging in the shaft, by applying its usual working load or something in excess of this. Others think that no useful purpose would be served, and that certainly loading in excess of the normal conditions might do damage. Professor Joseph Hrabak, of Pribram, carried out some interesting experiments to determine the elongation of wire ropes under known loads, and thus to find out the modulus of elasticity. He refers fully to these in his book 'Die Drahtseile,' and from the description of his tests it appears that the data were arrived at by loading the cage with men in many deep-level vertical shafts, and noting the elongation thus produced in the rope. In a 3,000-foot shaft the elongation amounted to about 1 inch per man, and it is, therefore, capable of being measured reliably and accurately. The modulus of elasticity of a winding rope will vary during its working life, being small at first, afterwards increasing to something nearer the value of the modulus of the wire itself, and then, if the rope is kept in use long enough, it will probably decrease. This last effect, if observed, is to be taken as a danger signal, pointing to the deterioration of the rope.

"On the whole, the Commission considers that the practice of making elongation tests of the whole rope is to be recommended, but that the ordinary working load should not be exceeded to more than the extent of doubling the authorised load of the skip or cage. It is also strongly recommended that when a winding rope is taken off and its life considered ended for the particular

purpose for which it was installed, a sample from the most worn place should be tested. The results of these tests should prove of the greatest service to the person who has had charge of the rope, as they would enable him to see how far his judgment was sound concerning its condition. It is not recommended that this practice should be made compulsory, for the reason that it would probably involve in most cases the wrecking of any utility that the rope might still possess for purposes other than that of transporting persons.

"A very important question arises in this section of the Commission's investigations, as to what loss of strength a rope has sustained owing to the removal by friction, etc., of a certain definite proportion of the cross-sectional area of the wires. To come to any sound conclusion regarding this matter, it is necessary to know what support is afforded to any individual wire by the gripping tendency of the adjacent wires. Mr. Epton, in his evidence, submitted the results of tests conducted by him of two rope samples, 26 inches in length between the grips, each specially prepared by having ten of the outside wires cut through. These tests showed that the supporting effect of the sound wires on the broken wires amounted practically to nothing. These samples were new or only slightly worn.

"Of ninety-one complete tests of worn ropes carried out in the Mines Department Mechanical Laboratory, 33 show that the laid-up wires have a greater strength than when tested individually at the most worn part, and 49 show the opposite, whilst eight give almost the same results, whether tested as separate wires, or in the form of a rope. It is interesting to note that the great majority of the ropes which tested higher than the aggregate of their wires, were of the simple construction, viz., six strands of seven wires, 6.6.1. All these results go to show that in a short length of rope—2 or 3 feet—the strength of the rope cannot fairly be assumed to amount to more than the aggregate strength of the wires, estimated in each case at the position of greatest wear, although these positions may not all occur at exactly the same point in the rope. Mr. Epton stated that in only five cases out of over 400 had he found ropes to break at a much lower load than was estimated from external appearances, the estimation having been made by assuming that there was no lateral support between adjacent wires. In these cases there were excessive internal corrosion and wear, and the first-named defect would probably have been quite as pronounced in a sample cut off from the end of the rope."

THE VENTILATION OF THE BATTERY TUNNEL.

A DESCRIPTION OF THE MACHINERY AND METHODS FOR THE VENTILATION OF THE BROOKLYN EXTENSION OF THE NEW YORK SUBWAY.

The Engineering Record.

THE problems connected with the ventilation of the Battery tunnels under the East River which will be opened for traffic within a few months were, owing to the length of the tubes and the character of the service to be handled, among the most difficult ever encountered in tunnel operation. They have therefore been carefully studied and the design finally selected is an example of the most advanced practice in tunnel ventilation. The following details of the ventilating plant and methods is taken from a recent number of *The Engineering Record.*

"The subaqueous connection has been built as two single-track parallel tubes, running from 26 to 28 feet apart on centers and about 6,750 feet in length. The tubes are cylindrical cast-iron shells, lined with concrete, having an inside diameter of 15½ feet and they were projected toward the center of the river with gradients of 3 1/10 per cent, which are united at the lowest point near the center of the river by a vertical curve, with the tops of the tubes about 80 feet below mean high water level in the river."

Under ordinary conditions it is expected that the piston action of trains running at high speed and on close headway will suffice for all ordinary requirements for ventilation but it was thought advisable to

install a complete system of mechanical ventilation for continuous use if necessary, and for ready use in case of emergency, such as the stalling of a train, etc. The system decided upon is that of blowing air into the tubes through jets or nozzles in the direction of motion of the trains, a system which experience has shown to be most effective for use in tunnels both ends of which must remain open. One of the great difficulties in the installation was the smallness of the nozzles which could be used in the restricted clearance space. Another difficulty was the procuring of suitable locations for the blowing stations. These were finally located, the one for the New York end in Battery Park, and the one for the Brooklyn side in Joralemon St., some three blocks back from the water front.

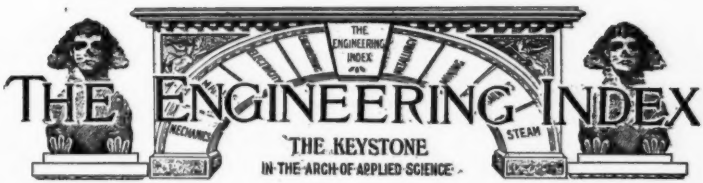
"After a careful study of the problem, the engineers in charge of the design decided that a volume of from 45,000 to 50,000 cubic feet per minute should be introduced into either tube for the results desired with provisions for a slight increase over this amount for emergency conditions. With the space available for nozzles, however, the areas of the orifices were limited somewhat, which factor, of course, largely influenced the capacities of blowers selected. The nozzles, although designed as large as possible for the spaces available are but 15⅜ inches wide by 4 feet total height, the upper corners being cut off by the upper portion of the tube shells, and have each a total cross sectional area of orifice of 5 square feet. Each tube thus has a total capacity of nozzle orifice of 10 square feet, each of the nozzles being supplied with air from the blowers through a converging connection from a delivery duct of 18 square feet cross section. The blowers selected as best adapted to this duty with these particular sizes of connections were centrifugal downward-discharge fans with 7-foot wheels, 4 feet in width. Operated against a static pressure of 0.33 ounce blast, each fan has a capacity for delivering 46,500 cubic feet per minute. The blowers are all ¾-housed steel plate centrifugal fans, and 2 units are installed in duplicate at each blower station, it being thought that with this provision of reserve capacity, no combination of conditions will ever arise in which at least one unit cannot be kept in running order in each station. Each of the blowers is direct-connected to a 75-h.p. interpole motor which is designed for operation on the 600-volt current from the third rail of the Subway propulsion system, and is fitted with control apparatus for a speed variation of from 300 to 413 revolutions per minute. The source of current supply has, also, been made doubly reliable by the extension of an independent feeder for this purpose from the substation of the Subway lines nearest to the blower stations, and a direct connection to the third rails in the adjoining tubes, although the latter will serve as an emergency connection only and will not be used under ordinary conditions. They are also fitted with automatic starting switches arranged for distant control, so that the blowers may be placed in operation upon an instant's notice from the office of one of the despatchers of the Subway lines. . . . . .

"The duct connections from the blowers to the nozzles are simply arranged, consisting in general of a vertical rectangular duct of No. 18 galvanized iron, which extends from the delivery outlets of each group of two fans directly downward to the tube through which air will normally be blown, with cross branches to the other sides of the shafts to connect with the reserve nozzles for reversal of the flow in the tubes, if this may be necessary in emergency. The down delivery ducts are of 18 square feet cross section which is ample to carry the maximum volume that can be delivered through the nozzles, and they divide over either tube, through a Y-connection, into two branches of 9 square feet section which supply the two nozzles, the branches and connection to the nozzles being similarly proportioned and shaped on either side in order to equalize the flow from either nozzle. The blowers deliver through connections of 16 square feet cross section which join at the top of the shaft into the down delivery ducts, special flap dampers being used at the joining to permit either blower desired to deliver independently, while in case it is desired to operate both blowers together, the dampers will assume a central position and thus not interfere with the delivery of either unit. The choice of these sizes of ducts is due to the fact that the capacity of the system is

limited by the areas of the nozzle orifices, upon which the design of the blowers was based; the effect of the nozzles is such that even with the second blower in operation, the volume delivered through them would be increased but to a slight extent, probably not over 20 per cent. The control of the delivery to the nozzles in either tube is had through sets of louvre dampers in the ducts at points immediately beyond the joining of the cross branch to the vertical duct, which dampers are interconnected and so actuated that the blowers cannot deliver into the nozzles of both tubes at the same time; these damper mechanisms in the two stations are furthermore fitted for distant electric control, by means of which the interlocking arrangement is secured, and which also permits of instantly changing the direction of flow in both tubes from a distant point. . . . .

"The distant control mechanism is of the electro-pneumatic type, the electrically-controlled pneumatic cylinders built by the Union Switch & Signal Co. for actuating signal mechanisms being used. As these cylinders are of the single-acting type, two are installed at each blower station, one for throwing the dampers in either position. They are mounted side-by-side on the side of the duct near the dampers and have their pistons connected to a rocker arm, pivoted at the middle, which carries a bell-crank so connected to the louvre dampers as to always maintain one closed while the other is open. The angles which the louvres assume when closed were so chosen in relation to the directions of flow that but about 60 degrees of movement of the vanes is required, and in order that the cylinders or levers may not stick in a partly opened position, positive throw spring attachments have been applied to the levers of either louvre which will always ensure completion of the motion of opening or closing, provided the cylinders throw the mechanism more than half way over. The electric air valves that control the pneumatic cylinders are actuated by the regular 16-volt direct-current supply for the signal system, a double-throw switch at the Bowling Green interlocking tower controlling both sets of cylinders; when thrown in one direction, it actuates simultaneously the cylinders in both blower stations for the direct flow, while in the other direction, the cylinders for the reverse flow. In this way the adjustments of the sets of dampers are positively interlocked and it is thus rendered impossible through mistake to direct the blast into both ends of either tube at one time. No provision has been made for directing the blast in the same direction through both tubes at the same time.

"The provisions for ventilation thus made enable a great variety of conditions to be met. Under ordinary conditions, it is, as above stated, expected that the air in the tubes will be maintained sufficiently clear for the comfort of the trainmen and passengers by the piston-action of the trains passing through, while, if in hot summer weather, more ventilation should prove desirable for cooling purposes, the operation of one of the blower units for either tube will add considerably to the effect of the trains. It is, however, in the case of a serious emergency that the full value of the ventilating equipments would be realized. While there is no danger from fire in the tunnels, as cars of metallic construction only are to be operated on the Brooklyn extension, the smoke that would result from a burnt-out motor or other derangement of the electrical apparatus of the propulsion system could incite a serious panic amongst passengers; such smoke or obnoxious gases in case of a stalled train can, with the blowers in operation, be rapidly dissipated, and, by virtue of the provisions for reversal of flow, in such a manner as to be least offensive to the people at the scene of the accident. By means of the system of telephones in the tubes, the trainmen may very quickly advise the despatcher if the reversal of flow is necessary, which is accomplished in the office of the latter by the mere throwing of a single-pole switch. Furthermore, if the blowers should happen not to be in operation, they could be instantly started by the mere throwing of another switch at the same point, one for either blower station, the blower motors being, as above stated, fitted with automatic starting equipments with distant control."



The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

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CIVIL ENGINEERING

BRIDGES.

Abutments.

Discussion, Design and Specifications for a Reinforced Concrete Bridge Abutment. T. M. Fyshe. Drawings with detailed description of the design, with related information. 8000 w. Can Soc of Civ Engrs—Oct. 17, 1907. No. 87854 N.

Anchorages.

Concrete Anchorage in the Brooklyn Bridge. Charles M. Ripley. On the Manhattan anchorage for Brooklyn Bridge, No. 3, and the contractor's plant and methods used. Ills. 2200 w. Cement Age—Oct., 1907. No. 87859.

Arch.

The Construction of the 175th Street Arch, New York City. Describes methods used in building an elliptical brick arch, of 66-ft. span and 20-ft. rise, built on a 9 deg. skew. Ills. 1500 w. Eng Age—Oct., 1907. No. 87859.

Failure.

The Ponts-de-Cé Disaster (La Catas-

We supply copies of these articles. See page 559.

trophe des Ponts-de-Cé). Jean Phizey. A description of the failure of this railroad bridge on August 4, by which a passenger train was precipitated into the River Loire. Ills. 4800 w. Génie Civ—Sept. 14, 1907. No. 87611 D.

Girders.

Continuous Girders. Gives calculations for determining the design of a type of railway overbridge. Ills. 2500 w. Engr, Lond—Sept. 27, 1907. No. 87525 A.

Lattice Girder.

Strengthening an Old Lattice Girder Bridge. George Jacob Davis, Jr. Notes on the method used in computing the stresses in the Leonard St. bridge, Grand Rapids, Mich., and its failure and strengthening. Ills. 1200 w. Eng Rec—Sept. 28, 1907. No. 87307.

Manhattan.

The Manhattan Bridge Pedestal. Outline description of this bridge across the East River, at New York, with illustrated detailed description of the design and construction of the pedestals. 2500 w. Eng Rec—Oct. 19, 1907. No. 87784.

Quebec.

The Erection of the South Cantilever Arm of the Quebec Bridge. Illustrates and describes details of erection of the south cantilever arm, not previously published. 3500 w. Eng Rec—Sept. 28, 1907. No. 87308.

The Collapse of the Quebec Bridge. Frank W. Skinner. Gives results of personal observations at the site of the Quebec Bridge disaster, attributing the accident to bad design. Also long editorial. Ills. 6800 w. Engng—Sept. 20, 1907. No. 87342 A.

The Compression Members of the Quebec Bridge. Editorial discussion, with letters bearing on the Quebec disaster from engineers of prominence. 9000 w. Eng News—Oct. 3, 1907. No. 87424.

The Quebec Bridge Wreck. Folding plate, with notes. 1800 w. Eng News—Oct. 10, 1907. No. 87552.

Theodore Cooper on the Quebec Bridge and Its Failure. The official statement of the consulting engineer for the Quebec bridge, to the Canadian Investigating Commission. 11500 w. Eng News—Oct. 31, 1907. No. 87992.

Rebuilding.

Calf Killer Bridge, Nashville, Chattanooga & St. Louis Ry. Detailed description of methods used in rebuilding this bridge with reasons for the re-erection. 2000 w. Eng Rec—Sept. 28, 1907. No. 87305.

Reinforced Concrete.

See under Viaduct.

Suspension.

See under Manhattan.

Viaducts.

The Nelson Street Viaduct at Atlanta. Illustrated description of a reinforced concrete structure of ten flat arch spans. 1000 w. Eng Rec—Oct. 12, 1907. No. 87570.

The Erection of the Moodna Creek Viaduct. Illustrates and describes the overhead traveler used which is of rather peculiar construction. 2000 w. Eng Rec—Oct. 26, 1907. No. 87936.

Ferro-Concrete Viaduct for the Cala Mineral Railway, Seville. Mateo Clark. Explains the conditions, and gives an illustrated description of the construction. 2000 w. Engng—Oct. 18, 1907. No. 87957 A.

CONSTRUCTION.

Beams.

Strain in Beams of Rectangular Section with Curved Axes (Die Anstrengung Stabförmiger Träger mit Gekrümmter Mittellinie). Carl Pfleiderer. A mathematical paper in extension of a previous paper in the same publication. Ills. 3600 w. Zeitschr d Ver Deutscher Ing—Sept. 21, 1907. No. 87652 D.

See also under Reinforced Concrete.

Buildings.

See under Reinforced Concrete.

Cement.

The Regulation and Control of Cement Construction. E. S. Larned. A discussion of the use of cement blocks with suggestions for specifications and uniform instructions. 3500 w. Cement—Sept., 1907. No. 87398 C.

Column Stresses.

Imperfect Butt-Joints in Columns, and Stresses in Lattice-Bars. Henry S. Prichard. Gives an analysis of the bending stresses so produced, illustrating by problems. 2000 w. Eng News—Oct. 3, 1907. No. 87425.

Concrete.

Concrete Construction. E. S. Larned. Read before the Am. Portland Cement Mfrs. Discusses its regulation and control. 3500 w. Ir Age—Oct. 10, 1907. No. 87537.

Sound Concrete Construction. J. T. Noble Anderson. Information based on experience. 2800 w. Engr, Lond—Oct. 4, 1907. Serial. 1st part. No. 87595 A.

Contractor's Plant.

An Unusual Plant for Constructing a Submarine Tunnel at Chicago. Illustrated description of a plant used in connection with the construction of the lake section of a new tunnel for the water-works system. An aerial tramway is a special feature. 5500 w. Eng Rec—Oct. 26, 1907. No. 87935.

Dams.

Masonry Dams. Thomas G. Bocking.

Gives examples illustrating the constructional practice of the five continents. Diagrams. 1500 w. Engr, Lond—Sept. 27, 1907. No. 87528 A.

Hydraulic Excavation and Dam Building at the Croton and Lyons Dams in Michigan. William G. Fargo. Illustrates and describes the plant and the work. 2500 w. Eng News—Oct. 24, 1907. No. 87872.

Crocker's Reef Dam Across the Hudson at Ft. Edward. Herbert Spencer. Illustrates and describes this rock-fill dam built in connection with the improvement of the Champlain Canal. 1500 w. Eng Rec—Oct. 5, 1907. No. 87447.

A Collapsible Steel Dam Crest, Bear River, Near Garland, Utah. J. C. Wheelon. Illustrated detailed description of a collapsible steel dam crest invented by the writer. It can be attached to either masonry or timber dams. 1000 w. Eng News—Oct. 3, 1907. No. 87421.

Filling.

Fills Made from Cars Running on a Suspended Cableway. Illustrated description of a suspension bridge system of making earth fills. 1500 w. Eng News—Oct. 10, 1907. No. 87550.

Fireproofing.

Fireproof Construction. M. M. Sloan. Discusses the requirements and special features of such structures. 3000 w. Archts & Bldrs' Mag—Oct., 1907. Serial. 1st part. No. 87974 C.

Foundations.

Foundations. Continued discussion of the best system for heavy structures on alluvial ground; the use of iron or steel when in contact with water; and the strength of concrete under stated conditions. 6500 w. Pro Am Soc of Civ Engrs—Sept., 1907. No. 87715 E.

Groynes.

Ferro-Concrete Groynes Near Brighton. Illustrated description of work on the foreshore to the east of Brighton, where the high chalk cliffs have suffered from erosion by the sea. 1200 w. Engr, Lond—Sept. 27, 1907. No. 87527 A.

Lookout Tower.

The Outlook Tower of Beinn Bhreagh, the First Iron Structure Built of Tetrahedral Cells. T. W. Baldwin. Illustrated description of an interesting experimental structure recently built by Dr. A. G. Bell at his summer home in Cape Breton. 1000 w. Sci Am—Oct. 5, 1907. No. 87474.

Reinforced Concrete.

The Reinforced Concrete Work of the McGraw Building. William H. Burr. Illustrated detailed description of a true reinforced-concrete strucutre, designed to afford the greatest possible resistance to the vibration of heavy machinery. 5800 w. Pro Am Soc of Civ Engrs—Oct., 1907. No. 87881 E.

Method and Cost of Constructing Reinforced Concrete Kiln House of Separately Molded Members, Edison Portland Cement Co. Gives data relating to a new kiln house at New Village, N. J., with illustrations. 2500 w. Engng-Con—Oct. 2, 1907. No. 87406.

Cast Concrete-Steel Members. Illustrated description of kiln houses of the Edison Portland Cement Co., where the members were cast and assembled like fabricated steel. 800 w. Ins Engng—Oct., 1907. No. 87856 C.

New Buildings of the King Plaster Mills, Staten Island. Five-story reinforced-concrete structures, occupying irregular areas, designed to support floor loads from 200 to 600 lbs. per square foot, are illustrated and described. 2000 w. Eng Rec—Sept. 28, 1907. No. 87313.

The New Plaster Mill of the American Gypsum Co. Describes a fireproof reinforced concrete building near Port Clinton, O. Ills. 1800 w. Eng Rec—Oct. 12, 1907. No. 87568.

Method and Cost of Building a Reinforced Concrete Car Barn. Illustrated detailed description, with costs, of a barn at Easton, Pa. 1100 w. Engng-Con—Oct. 23, 1907. No. 87888.

Report of the Special Committee on Reinforced Concrete of the Engineers' Club of St. Louis Embodied in the Building Ordinances of the City of St. Louis. 5500 w. Jour Assn of Engng Socs—Sept., 1907. No. 87863 C.

An Analytic and Graphic Method of Determining the Section of Reinforced Concrete Beams (Ein Weg zur Analytischen und Graphischen Behandlung des mit Eisen Armierten Betonquerschnittes). Rudolf Pokorny. A mathematical paper on the design of reinforced-concrete members. Ills. 3200 w. Zeitschr d Oest Ing u Arch Ver—Sept. 6, 1907. No. 87645 D.

The Design of Rigid Frames (Beitrag zur Berechnung Steifer Rahmenkonstruktionen). Otto Leuprecht. A mathematical paper with worked-out examples. Ills. 2200 w. Serial. 1st part. Beton u Eisen—Sept., 1907. No. 87655 F.

See also under Anchorages and Abutments and under same title, under Bridges.

Reservoir Leak.

Repairing a Remarkable Leak in a Reservoir Embankment at Providence, R. I. Extract from report of Otis F. Clapp, describing the work. 600 w. Eng News—Oct. 17, 1907. No. 87740.

Retaining Wall.

The Melwood Avenue Retaining Wall,

Pittsburg. Describes the construction of a reinforced-concrete retaining wall about 220 ft. long which has a maximum height at the center of 64 ft., exclusive of the 4-ft. parapet wall. Ills. 1500 w. Eng Rec—Sept. 28, 1907. No. 87309.

Roads.

See under Municipal.

Scraper Work.

Methods and Cost of Moving Earth in the Fresno Scrapers in Arizona, and the Cost of Trimming Slopes. An account of work in grading a railroad bed. 1500 w. Engng-Con—Oct. 2, 1907. No. 87407.

Sewers.

See under Municipal.

Shingles.

Asbestos Shingles. Charles H. Stringer. Explains the advantages of the use of composition of fibre and cement. 1200 w. Ins Engng—Oct., 1907. No. 87855 C.

Tunnel Lining.

Lining a Tunnel with Concrete. Illustrates and describes work on the Southern Ry. in Indiana. 2000 w. Eng Rec—Oct. 12, 1907. No. 87565.

Tunnels.

The Reconstruction of the Eighth Street Tunnel, Kansas City, Mo. Describes work for the Metropolitan Street Railway Co., which required changing the grade in the tunnel. 1700 w. Eng Rec—Oct. 5, 1907. No. 87451.

The Detroit River Tunnel. An illustrated description of the methods used in sinking steel shells in a dredged trench. 3000 w. Eng News—Oct. 31, 1907. No. 87984.

See also under Contractor's Plant.

Underpinning.

Underpinning Adjacent to the Silversmiths' Building, New York. Explains conditions adjacent to the site for this 20-story, steel-cage building, and illustrates and describes methods of supporting the adjoining buildings. 3000 w. Eng Rec—Sept. 28, 1907. No. 87310.

MATERIALS OF CONSTRUCTION.

Cement.

Qualities and Methods of Using Cement. S. B. Newberry. Abstract from a paper before the Ohio Bldrs. Sup. Assn. Considers qualities of various cements and methods of use. 2000 w. Munic Engng—Oct., 1907. No. 87393 C.

See also under Slag Cement.

Concrete.

Results of a New Series of Tests on the Shearing Strength of Plain and Reinforced Concrete (Ergebnisse einiger neuen Versuche über den Scherwiderstand Reiner und Armierter Betonprismen). J. E. Brik. Tests made on small square-section blocks with longitudinal reinforcement. Ills. 2000 w. Oest Wochenschr f d Oeffent Baudienst—Sept. 7, 1907. No. 87641 D.

Paints.

A New Blue-Black Iron Paint as a Protective Covering. F. J. R. Carulla. Read before the Ir. & St. Inst., at Vienna. Describes an English patented process, utilizing "waste pickle" liquors. 800 w. Mech Engr, Lond—Sept. 28, 1907. No. 87510 A.

Slag Cement.

Tests of the Strength of Slag Cement (Versuche über die Festigkeit von Schlackenbeton). G. Kaufmann. Gives results of compression and shear tests, with applications to formulæ. Ills. 3000 w. Beton u Eisen—Sept., 1907. No. 87654 F.

Timber.

Maximum Length of Service for Poles, Ties and Timbers. Edward J. Weihe. Presents facts in regard to the structure, seasoning, and preservative treatment. 2800 w. St Ry Jour—Oct. 12, 1907. No. 87775.

Timber Preservation.

The Steaming of Timber. Octave Chanute. Read before the Nat. Assn. of Wood Preservers. Considers that the condition of the wood determines whether it is advisable to steam or not. 1800 w. Munic Engng—Oct., 1907. No. 87394 C.

Results of Recent Work of the Timber Tests by the Forest Service, United States Department of Agriculture. W. Kendrick Hatt. 3000 w. Am Ry Engng & Main of Way Assn, Bul 85—March, 1907. No. 87887 N.

A New Injection Process of Timber Treatment (Nouveau Procédé d'Injection des Bois). M. F. Lantier. Describes methods and apparatus for treating timber by the Rüping creosoting process. Ills. 5000 w. Rev Gen des Chemins de Fer—Sept., 1907. No. 87602 G.

MEASUREMENT.

Beams.

A Note on the Effect of the Time Element in Loading Reinforced Concrete Beams. W. K. Hatt. Read before the Am. Soc. for Test. Mat. Records general results of tests made. Ills. 1200 w. Eng News—Oct. 24, 1907. No. 87874.

Strength of Materials.

The Work of Deformation as a Measure of the Strength of Materials (Ueber die Deformationsarbeit als Mass der Beanspruchung). Rudolf Girtler. A mathematical demonstration with concrete examples. Ills. 3500 w. Zeitschr d Oest Ing u Arch Ver—Sept. 13, 1907. No. 87646 D.

Surveying.

Triangulation and Traverse Work in the Bronx, New York City. Notes from

We supply copies of these articles. See page 559.

a paper by Edward H. Holden, read before the Munic. Engrs. of the City of New York, explaining some of the methods followed in the work. 2500 w. Eng Rec —Oct. 5, 1907. No. 87450.

Surveying Tapes.

Invar (Nickel-Steel) Tapes on the Measurement of Six Primary Base Lines. Owen B. French. Reports investigations made of the properties of invar tapes, with results of work and statement of advantages. 7700 w. Pro Am Soc of Civ Engrs—Oct., 1907. No. 87882 E.

Telemeter.

Commandant Gérard's Telemeter. Illustrated description of an instrument for measuring distances from the observer to an object. 1500 w. Sci Am—Oct. 26, 1907. No. 87879.

Testing Materials.

Investigations of Structural Materials by the United States Geological Survey. Richard L. Humphrey. An illustrated account of the work at the testing laboratories at St. Louis. 2500 w. Cement—Sept., 1907. No. 87397 C.

Government Work in the Testing of Materials. Editorial discussion of how far the Federal Government may advantageously carry this work. 2000 w. Eng News—Oct. 17, 1907. No. 87742.

Test of a Reinforced Concrete Beam. Guy O. Fraser. A detailed account of the test representing actual working conditions. 2800 w. Cal Jour of Tech—Oct., 1907. No. 87981.

Compression Tests of the French Government Commission. Leon S. Moisseiff. Describes compression tests on longitudinally reinforced columns. Ills. 2500 w. Cement—Sept., 1907. No. 87396 C.

MUNICIPAL.

Drainage Canal.

A Favorable Report on the Calumet Drainage Canal. Gives the projects under discussion in connection with the sewage disposal of this district of Chicago, and the opinion of Mr. Rudolph Hering. 2500 w. Eng Rec—Oct. 26, 1907. No. 87937.

Municipal Planning.

City Planning and Replanning. Editorial discussion of points deserving attention. 2000 w. Eng News—Oct. 31, 1907. No. 87991.

Pavements.

Pavements. Continued discussion of whether paving materials of the present will be used in the future. 7000 w. Pro Am Soc of Civ Engrs—Sept., 1907. No. 87716 E.

Roads.

The Construction of Macadam Roads. Austin B. Fletcher. A brief description and discussion of the processes and essential features. Also data as to costs. Ills. 18000 w. U S Dept of Agri—Bul. 29. No. 87867 N.

Methods and Cost of Building Macadam Roads in the State of Washington. From a paper by A. L. Valentine, read recently before the Pacific N.-W. Soc. of Civ. Engrs. 2000 w. Engng-Con—Oct. 2, 1907. No. 87408.

Sewage Disposal.

A New Zealand Method of Sewage Treatment for Isolated Buildings. John Mitchell. Extracted from "Some Thoughts Upon Rural Sanitation and Suggestions for a Betterment." 1800 w. Eng News —Oct. 31, 1907. No. 87990.

Sanitation in the Suburbs of Paris (Assainissement de la Banlieue de Paris). Describes principally the Suresnes sewerage siphon under the Seine and outlines other projects for the purification of the waters of the river. Ills. 2400 w. Génie Civ—Sept. 7, 1907. No. 87610 D.

Sewage Purification.

The Sewage Purification Plant at Reading, Pennsylvania. Illustrated detailed description of a new installation consisting of a sewage screening device, a septic tank, a sprinkling filter, and a final settling basin. 5000 w. Eng Rec—Oct. 5, 1907. No. 87441.

Sewers.

A Large Sewer Project in St. Paul, Minn. Plan and description of the construction of a deep drop shaft and tunnel as part of a system to serve a manufacturing district. 1200 w. Eng Rec—Oct. 5, 1907. No. 87443.

Trenches.

Back-Filling Trenches. George C. Warren. Read at Detroit, before the Am. Soc. of Munic. Imp. Discusses some difficulties in connection with back-filling of trenches in city streets both as regards efficiency and economy. 3000 w. Eng Rec—Oct. 5, 1907. No. 87448.

WATER SUPPLY.

Concrete Pipes.

The Testing of Clay and Concrete Pipes. Abstracts of parts of a report of Burchartz and Stock of the royal building material testing department in Gross-Lichterfelde upon tests of clay and cement pipes. 1600 w. Munic Engng—Oct., 1907. No. 87395 C.

Small Cement Pipe for Irrigation. Albert Eugene Wright. Data on the construction, cost and strength. 2000 w. Cal Jour of Tech—Oct., 1907. No. 87980.

Percolating Beds.

The Time of Passage of Liquid Through Percolating Beds. William Clifford. A report of investigations, giving tabulated results. 800 w. Eng News —Oct. 17, 1907. No. 87739.

We supply copies of these articles. See page 559.

Pipe Friction.

Experiments with Submerged Tubes 4 Ft. Square. C. B. Stewart. Describes experiments made at the University of Wisconsin on the effects of changing the length of the tube and of modifying the entrance conditions. Also outlines a plan for future experiments. Ills. 2000 w. Eng Rec—Sept. 28, 1907. No. 87312.

Purification.

Electrolytic Treatment of Water for Technical Uses. Dr. Herman Fleck. Reports of electro-filtration tests made at Denver, Colo. 1000 w. Min Rept—Oct. 17, 1907. No. 87799.

Water Purification at St. Louis, Mo. Edward E. Wall. An illustrated description of the plant and process for clarifying and purifying the water supply, and the conditions previous to its use. 7000 w. Pro Am Soc of Civ Engrs—Sept., 1907. No. 87712 E.

Water Supply. Informal discussion on whether it is better to control watersheds or rely on filtration to purify the water. 2500 w. Pro Am Soc of Civ Engrs—Sept., 1907. No. 87714 E.

Examination of Water Purification Plant at Owensboro, Ky. Philip Burgess. Gives report of an examination made of a recently completed plant, with special reference to results obtained. 2000 w. Eng Rec—Sept. 28, 1907. No. 87306.

The Water Purification Plant of Harrisburg, Pa. Describes the operation of the filters and the apparatus used. Ills. 3500 w. Munic Engng—Oct., 1907. No. 87392 C.

Water Softening and Purification Plant of the Pennsylvania Railroad at Hartsdale, Ind. Illustrated description of a recently installed plant. 1400 w. Ir Trd Rev—Oct. 10, 1907. No. 87539.

Sterilization.

New Apparatus for the Sterilization of Drinking Water by Heat. Illustrates and describes the system of operation of the Forbes water-sterilizing system. 4000 w. Eng News—Oct. 31, 1907. No. 87987.

Typhoid Fever.

Engineering Studies of a Typhoid Outbreak at the State Hospital, Trenton, N. J. From the report of the State Sewerage Commission showing it to be due to the pollution of a portion of the water supply. Also a report by Dr. Henry Mitchell attributing the outbreak to personal contact. 4500 w. Eng News—Oct. 3, 1907. No. 87422.

Waste.

Water-Waste Investigations in Philadelphia. Reports investigations undertaken to measure the amount of water delivered by each pump to determine whether the pumps were operated economically; to ascertain whether the reservoirs were leaking; and to determine just what becomes of the water after it leaves the reservoirs. 2700 w. Eng Rec—Oct. 5, 1907. No. 87442.

WATERWAYS AND HARBORS.

Danube.

The Sulina Mouth of the Danube. An account of the radical changes made, including the elimination of curves, shortening this branch eleven miles, deepening the channel and removing obstructions, etc. 2500 w. Engr, Lond—Sept. 20, 1907. No. 87345 A.

Docks.

New Graving Docks and Shipyard on the River Tees. Illustrates and describes this dock scheme and proposed improvements. 1800 w. Engr, Lond—Oct. 18, 1907. No. 87964 A.

Dredges.

A New Flexible Connection for Suction Pipes of Dredges. Illustrates and describes a device designed to replace rubber hose and obviate its disadvantages. 1000 w. Eng Rec—Oct. 19, 1907. No. 87789.

Dredging.

A Sea-Going Bucket Dredge. Dr. Alfred Gradenwitz. Illustrated description of the Fedor Solodoff, a suction-pipe type with floating conduits, for service on the River Don and on the Sea of Azoff. 1600 w. Int Marine Engng—Nov., 1907. No. 87810 C.

The Excavation of the West Neebish Channel in the St. Mary's River, Michigan. Illustrated description of important work to facilitate navigation. 3000 w. Eng News—Oct. 10, 1907. No. 87546.

Flood Prevention.

Floods and Means of Their Prevention in Our Western Rivers. T. P. Roberts. Discussion of this paper. 17800 w. Pro Engrs' Soc of W Penn—Oct., 1907. No. 87860 D.

Flood Protection.

Flood Protection in Hungary (Der Hochwasserschutz in Ungarn). E. von Kvassay. Discusses the importance of regulating the rivers of Hungary and the works which have been undertaken for that purpose. Ills. 4400 w. Serial. 1st part. Oest Wochenschr f d Oeffent Baudienst—Sept. 7, 1907. No. 87642 D.

Groynes.

See under same title under Construction.

Havre.

The Development of the Port of Havre. Map, plans and description of the works carried out under the 1895 scheme, and the proposals for future extensions. 3000 w. Engr, Lond—Oct. 11, 1907. No. 87839 A.

Levee.

New Methods for Closing a Crevasse in a Mississippi River Levee: the Live Oak Crevasse, Louisiana. Mary W. Mount. The manner of effecting the closing is illustrated and described. 2200 w. Eng News—Oct. 24, 1907. No. 87873.

Mississippi Valley.

The Deep-Water Route from Chicago to the Gulf. Map and illustrations, with information and discussion of proposed improvements of the waterways of the Mississippi valley. 4000 w. Nat Geog Mag—Oct., 1907. No. 87710 C.

Nile.

The English on the Nile (Die Engländer am Nil). Franz Ritter. A description of the problem of regulating and utilizing the waters of the Nile and the works accomplished and in progress. 3600 w. Serial. 1st part. Zeitschr d Oest Ing u Arch Ver—Sept. 20, 1907. No. 87647 D.

Tennessee River.

Water-Power: By-Product of Navigation Improvement. Charles H. Baker. An account of the improvement of the Tennessee River and the project for the establishment of navigation over shoals, and the development of water-power in connection. Ills. 3000 w. Mfrs' Rec—Oct. 10, 1907. No. 87533.

U. S. Waterways.

President Roosevelt on Improvement of National Waterways. Extracts from address at Memphis, with editorial. 4500 w. Eng News—Oct. 10, 1907. No. 87553.

MISCELLANY.

Computing.

On Computing. Russell Tracy Crawford. Presents practical suggestions, some of which have not previously appeared. 3500 w. Cal Jour of Tech—Oct., 1907. No. 87982.

ELECTRICAL ENGINEERING

COMMUNICATION.

Oscillators.

On the Elementary Theory of Electric Oscillators. J. A. Fleming. An explanation of the theory of the oscillator for a few of the simple and most practically important forms of open and closed radiating circuit. 3500 w. Elect'n, Lond—Sept. 27, 1907. Serial. 1st part. No. 87514 A.

Radio-Telephony.

Long Distance Wireless Telephony. R. A. Fessenden. An account of the system in operation between Brant Rock and New York—nearly 200 miles—discussing the possibilities. Ills. 2200 w. Elect'n, Lond—Oct. 4, 1907. No. 87590 A.

Relays.

Alternating-Current Relays on the Ferraris Principle (Zur Frage der Wechselstrom-Relais nach dem Ferraris-Prinzip). R. David and Dr. K. Simons. A mathematical paper discussing their efficiency. Ills. 2000 w. Elektrotech Zeitschr—Sept. 26, 1907. No. 87661 D.

Telegraphone.

The Latest Forms of the Telegraphone (Die Neuesten Formen des Telegraphons). E. Hytten. Illustrated description of the latest applications of Poulsen's device. 1800 w. Elektrotech Zeitschr—Sept. 5, 1907. No. 87656 D.

Telephone Siwtchboards.

Multiple Telephone Switchboards with Central Battery and Luminous Signals (Les Commutateurs Téléphoniques Multiples à Batterie Centrale et à Signaux Lumineux). A. Le Vergnier. Principally devoted to a description of installations on the Siemens & Halske system. Ills. 3800 w. Génie Civ—Sept. 28, 1907. No. 87612 D.

Telephotography.

Recent Developments in Picture Telegraphy. Dr. Alfred Gradenwitz. An illustrated report of tests made of the Korn apparatus, and description of the invention of H. Carbonelle. 1000 w. Sci Am—Oct. 26, 1907. No. 87878.

Wire Testing.

Wire Testing. L. M. Jones. Briefly considers the methods which have given satisfactory results. 2000 w. R R Gaz—Sept. 6, 1907. No. 87901.

DISTRIBUTION.

Insulators.

The Design and Testing of Electrical Porcelain. Dean Harvey. Describes methods and processes in preparing porcelain insulators. Ills. 3000 w. Elec Jour—Oct., 1907. No. 87561.

DYNAMOS AND MOTORS.

Auxiliary Poles.

The Influence of Auxiliary Poles on the Operation of Dynamos and Motors (Ueber den Einfluss der Wendepole auf die Wirkungsweise von Generatoren und Motoren). Hermann Zipp. A mathematical paper. Ills. 3500 w. Elektrotech u Maschinenbau—Sept. 8, 1907. No. 87632 D.

D. C. Motors.

Some Notes on the Care and Working of Continuous-Current Motors. Deals

We supply copies of these articles. See page 559.

with the brushes, commutators, and points requiring attention in connection with these motors. 1200 w. Prac Engr—Sept. 20, 1907. No. 87331 A.

Induction Motors.

The Heyland Method of Starting and Regulating, and of Compensation for Phase Shifting of Induction Motors (Das Heylandsche Verfahren zum Anlassen und Regulieren und zur Kompensation der Phasenverschiebung von Induktionsmotoren). F. G. Wellner. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 7, 1907. No. 87649 D.

Starters.

A New Automatic Method of Starting Motors. Dr. Martin Kallmann. Abstract from *Elek. Zeit.* An account of the application of iron resistances to the starting of motors, describing various forms. 1200 w. Elect'n, Lond—Oct. 11, 1907. No. 87835 A.

Synchronous Motors.

Excitation Characteristics of the Synchronous Motor. A. S. Langsdorf. A mathematical study stating the assumptions. 800 w. Elec Wld—Oct. 19, 1907. No. 87804.

Turbo-Generators.

Continuous-Current Turbo-Generators (Gleichstrom-Turbogeneratoren). H. I. C. Beyer. A discussion of the points of design in which they differ from the normal type of dynamo. Ills. 4000 w. Serial. 1st part. Elektrotech u Maschinenbau—Sept. 29, 1907. No. 87635 D.

ELECTRO-CHEMISTRY.

Electro-Metallurgy.

Applied Electro-Metallurgy Up to the End of 1906. John B. C. Kershaw. This second article gives a review of the ferro-alloys, iron and steel, lead, nickel, siloxicon, silicon, sodium, tin, and zinc processes. Ills. 3000 w. Engineering Magazine—Nov., 1907. No. 87968 B.

Phosphorus.

Production of Phosphorus in the Electric Furnace. From an article by George W. Stose, in a recent publication of the U. S. Geol. Surv. Reviews old methods of making phosphorus, and gives information in regard to recent processes. 2200 w. Elec-Chem & Met Ind—Oct., 1907. No. 87503 C.

ELECTRO-PHYSICS.

Hysteresis.

Magnetic Hysteresis Phenomena. M. O. Bolser. Describes a device for showing the cyclic change in reluctance when a portion of a transformer core is revolved synchronously with the alternation of the flux. 1100 w. Elec Wld—Sept. 28, 1907. No. 87320.

Induction Coils.

The Secondary Current of the Induction Coil. H. Clyde Snook. A discussion of the currents flowing in the secondary of an induction coil, as observed by means of a Duddell High Frequency Oscillograph. Ills. 2200 w. Jour Fr Inst—Oct., 1907. No. 87759 D.

Oscillations.

The Poulsen Arc as a Means of Obtaining Continuous Electrical Oscillations. J. A. Fleming. Abstract of a paper read before the Phys. Soc. Describes experiments on the Poulsen arc, and discusses results. 3500 w. Elect'n, Lond—Sept. 20, 1907. No. 87339 A.

GENERATING STATIONS.

Blast Furnace Gas.

The Economic Distribution of Electric Power from Blast Furnaces. B. H. Thwaite. Read before the Ir. & St. Inst. at Vienna. Describes an application of the pooling system proposed by the writer. Ills. 3500 w. Mech Engr, Lond—Sept. 28, 1907. No. 87509 A.

Central Stations.

Recent Developments in Steam Turbine Power Station Work, with Special Reference to the Fort Wayne & Wabash Valley Traction Company Spy Run Station. J. R. Bibbins. Describes a particular design of station for steam turbine power, the construction and operation. Ills. 6800 w. St Ry Jour—Oct. 19, 1907. No. 87818.

The Park Royal Generating Station of the Great Western Railway, London. Illustrated description. 3200 w. Elec Wld—Oct. 19, 1907. No. 87803.

Spring Street Station of the Columbus Railway and Light Company. Illustrates and describes a 6,500 kw. station for railway service. 1500 w. Engr, U S A—Oct. 15, 1907. No. 87731 C.

Operating Features of the Fifty-ninth Street Station of the Interborough Rapid Transit Company. Describes the operation of a station built on the unit system. 3500 w. St Ry Jour—Oct. 12, 1907. No. 87781.

Gas-Power Central Station of the Duquesne Light Co., Pittsburg, Pa. Norman C. MacPherson. Read before the Pittsburg Branch of the A. I. E. E. Detailed description of the equipment and operation. 4000 w. Eng Rec—Oct. 26, 1907. No. 87938.

The New Power Plant of the Lowell (Mass.) Electric Light Corporation. Illustrated description of the new turbine power station under construction. 2200 w. Elec Wld—Oct. 5, 1907. No. 87485.

A Central Power Station in the Whitewood. S. D., Mining District. Illustrates and describes a plant at Deadwood, built to supply electric current for power in the mines and mills in its vicinity, and

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for lighting in Deadwood, Lead and other camps. 1800 w. Eng Rec—Sept. 28, 1907. No. 87311.

Power Plant of the Gulfport and Mississippi Coast Traction Co. Earl F. Scott. Illustrated description of a plant designed to furnish light and power for several towns and for interurban electric traction. 2200 w. Eng Rec—Oct. 19, 1907. No. 87787.

A Modern Central Station (Ein Modernes Elektrizitätswerk). Dr. Müllendorff. Illustrates and describes the steam-turbine station of the city of Eberswalde, Germany. 3500 w. Glasers Ann—Sept. 1, 1907. No. 87637 D.

See also Street and Electric Railways, under Long Island R. R., New York Central R. R. and West Jersey and Seashore R. R.

Construction.

Modern Power Station and Electrical Construction. W. A. Haller. Deals especially with the constructional features pertaining to tne installation of turbo-generators and their supplementary apparatus. Ills. General discussion. 6000 w. Jour Assn of Engng Socs—Sept., 1907. No. 87862 C.

Hydro-Electric.

Three Low-Head Hydro-Electric Developments in Michigan. Illustrates and describes hydro-electric developments of the Grand Rapids-Muskegon Power Co. in the southern and western part of Michigan. 7500 w. Eng Rec—Oct. 19, 1907. Serial. 1st part. No. 87783.

Loch Leven Water Power Works. Illustrated description of a scheme to furnish electric power for the manufacture of aluminium. 1000 w. Engr, Lond—Oct. 4, 1907. No. 87597 A.

Recent Water-Power Plant in Switzerland (Neue Wasserkraftanlagen der Schweiz). S. Herzog. A series of articles illustrating and describing a number of hydro-electric developments, the first being a plant on the Rabiusa at Chur. 2000 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—Sept. 10, 1907. No. 87636 D.

The Caffaro Hydro-Electric Plant (Ancora dell' Impianto Idroelettrico del Caffaro). S. Herzog. Illustrated detailed description of this Italian plant. 2100 w. Serial. 1st part. L'Industria—Sept. 15, 1907. No. 87613 D.

Isolated Plant.

The Electric Light and Power Plant in the "Warehouse of the West" in Berlin (Die Elektrische Licht- und Kraftanlage im "Kaufhaus des Westens" zu Berlin). R. Zaudy. Illustrates and describes a plant of about 650 horse-power. 2500 w. Elektrotech Zeitschr—Sept. 26, 1907. No. 87660 D.

London.

London's Electricity Supply. Explains conditions in London and briefly discusses the schemes proposed at different times and rejected. 2800 w. Engr, Lond—Sept. 27, 1907. No. 87526 A.

Parallel Operation.

The Influence of Damping on the Parallel Operation of Alternating-Current Machines (Der Einfluss der Dämpfung auf die Schwingungsvorgänge in Parallel Geschalteten Wechselstrommaschinen). Fritz Emde. A mathematical discussion. Ills. 4800 w. Elektrotech u Maschinenbau—Sept. 22, 1907. No. 87634 D.

Sub-Stations.

The Connection of Cables to Switchboards in Underground Sub-Stations. W. Pleasance. Brief notes on some of the small but important details of underground sub-stations. Ills. 800 w. Elec Engr, Lond—Sept. 20, 1907. No. 87333 A.

Switchboards.

Switchboards for Small Stations. E. T. Mug. Suggestions for the design and arrangement. Diagrams. 1400 w. Elec Rev, N Y—Oct. 5, 1907. No. 87440.

The New Switchboard of the International Electric Company in Vienna (Die Neue Schaltanlage der Internationalen Elektrizitäts-Gesellschaft in Wien). Oskar Spitzer. Illustrated description. 1600 w. Elektrotech u Maschinenbau—Sept. 1, 1907. No. 87631 D.

Turbo-Generators.

Curtis Turbines in Railway Service. August H. Kruesi. Read before the Am. St. & Int. Ry. Engng. Assn. Reports results of three recent tests and discusses the advantages of turbine generators. 2500 w. St Ry Jour—Oct. 19, 1907. No. 87817.

LIGHTING.

Arc Lamps.

Invention of the Enclosed Arc Lamp. L. B. Marks. Gives the history of the progress in solving this problem. Ills. 1200 w. Sibley Jour of Engng—Oct., 1907. No. 87865 C.

Cities.

Public Lighting Service, Corporate and Municipal. Judson H. Boughton. A study of electric stations, giving unit costs of plant and operation from many installations. 3500 w. Engineering Magazine—Nov., 1907. No. 87972 B.

Illumination.

Calculation of Illumination from Inclined Light Sources. J. S. Codman. Mathematical. 800 w. Elec Rev, N Y—Oct. 5, 1907. No. 87439.

Incandescent Lamps.

Developments in Electric Incandescent Lamps. Leon Gaster. Reviews some of

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the more important improvements. 3800 w. Cent Sta—Oct., 1907. No. 87563.

See also under Nernst Lamp and Tantalum Lamp.

Mechanical Equivalent.

The Mechanical Equivalent of Light. Reviews the measurements of Dr. C. V. Drysdale and A. C. Jolley, their methods, and the results. 1400 w. Engng—Oct. 18, 1907. No. 87959 A.

Nernst Lamps.

The Value of the Nernst Lamp to the Central Station. A. E. Fleming. Explains some of the advantages of the Nernst system. 2200 w. Cent Sta—Oct., 1907. No. 87562.

Singer Building.

The Electric Illumination and Wiring of the Singer Building. Illustrated description of the plant and the installation. 3500 w. Elec Age—Oct., 1907. No. 87868.

Tantalum Lamp.

The Deformation of the Tantalum Filament when Used with Alternating Current. F. Stroude Stud. Brief note on the observed deformation and its cause, with suggestion for improving the tantalum lamp. 700 w. Elec Engr, Lond—Sept. 20, 1907. No. 87332 A.

MEASUREMENT.

Alternating Current.

The Application of the Alternating-Current Arc in Electrical Measurements (Die Verwertung des Lichtbogen-Wechselstromes in der Messtechnik). C. Heinke. A mathematical paper discussing the application of the high-frequency arc to the determination of alternating-current coefficients. Ills. 4000 w. Elektrotech Zeitschr—Sept. 19, 1907. No. 87659 D.

Condensers.

Simultaneous Measurement of the Capacity and Power Factor of Condensers. Frederick W. Grover. Deals with the determination of the power factor of condensers to be used for precision measurements of inductance and capacity. 13800 w. Bul Bureau of Stand—Aug., 1907. No. 87701 N.

Insulation Resistance.

A Method of Testing D. C. Networks for Insulation Resistance During Working. Daniel Shirt. Describes test, illustrating by example. 600 w. Elec Rev, Lond—Oct. 11, 1907. No. 87831 A.

Meter Bridge.

A Home-Made Slide-Wire Electrical Bridge. Henry C. Ter Meer. Illustrates and describes a method of constructing a modified meter bridge. 1000 w. Sci Am Sup—Oct. 19, 1907. No. 87743.

Motor Testing.

The Commercial Testing of Series Motors. Gives schemes of connections for testing, with particular reference to those designed for diverter control. 700 w. Elec Rev, Lond—Sept. 20, 1907. No. 87338 A.

Permeability.

The Permeability of Alloyed Irons at High Flux Densities. E. A. Watson. Describes a method of testing small samples at high flux densities, and gives results obtained on alloyed irons at densities such as commonly occur in armature teeth. 1500 w. Elect'n, Lond—Oct. 18, 1907. No. 87955 A.

Photometry.

On the Determination of the Mean Horizontal Intensity of Incandescent Lamps. Edward P. Hyde and F. E. Cady. Gives method and results of recent experiments to study the accuracy of the rotating lamp method. 4000 w. Bul Bureau of Stand—Aug., 1907. No. 87700 N.

Resistance Coils.

Resistance Coils and Comparisons. C. V. Drysdale. Read before the British Assn. at Leicester. An illustrated account of the principal types of coils and methods of measurement is given, with description of some new forms. 1000 w. Elect'n, Lond—Sept. 27, 1907. Serial. 1st part. No. 87516 A.

Transformer Testing.

On Transformer Indicator Diagrams. T. R. Lyle. Abbreviated paper, read before the Physical Soc. Describes the use of the author's wave tracer and analyzer. 2500 w. Elect'n, Lond—Oct. 11, 1907. No. 87834 A.

Units.

A New Determination of the Ratio of the Electromagnetic to the Electrostatic Unit of Electricity. E. B. Rosa and N. E. Dorsey. Gives work undertaken to make a new determination of the value of V, using the method of capacities. Ills. 21000 w. Bul Bureau of Stand—Aug., 1907. No. 87702 N.

Voltage Drop.

A Graphical Method of Determining the Voltage Drop in Power Distribution Systems. T. L. Kolkin. Explains method, dealing with cases in common practice. 1500 w. Elec Rev, Lond—Oct. 11, 1907. No. 87832 A.

TRANSMISSION.

Cable Breakdown.

The Accident to Sydney Tramway Feeders. An illustrated account of a breakdown caused by the dragging of a feeder cable by a ship's anchor. 1200 w. Elec Rev, Lond—Oct. 4, 1907. No. 87589 A.

Cables.

Practical Notes on Plumbed Joints. W. Pleasance. Instructions in regard to

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lead-covered cables. 1800 w. Elec Engr, Lond—Oct. 4, 1907. No. 87588 A.

Conduits.

A Method of Laying Vitrified Conduits for Electrical Cables, and a Collapsible Core for Forming Conduits in Concrete Without the Use of Vitrified Ducts. F. Lavis. Describes work in the Pennsylvania Railroad tunnels and methods used. Ills. 1200 w. Eng News—Oct. 3, 1907. No. 87423.

Direct Current.

The Fleury Direct-Current Transmission System. D. Kos. A discussion of the principal features and its possibilities. Also editorial. 8500 w. Elec Wld—Oct. 26, 1907. No. 87949.

Grounded Neutral.

Earthing the Neutral Point. E. V. Shaw. Explaining the advantages of the automatic earth switch invented by the writer. 1200 w. Elec Rev, Lond—Oct. 18, 1907. No. 87954 A.

The Grounded Neutral, With and Without Series Resistance, in High-Tension Systems. Paul M. Lincoln. Discusses, from the viewpoint of the operating engineer, the advantages and disadvantages of a grounded neutral. 4000 w. Pro Am Inst of Elec Engrs—Sept., 1907. No. 87719 D.

Experience with a Grounded Neutral on the High-Tension System of the Interborough Rapid Transit Company. George I. Rhodes. Explains conditions which led to the grounding of the neutral, and reports successful results. 1500 w. Pro Am Inst of Elec Engrs—Sept., 1907. No. 87720 D.

The Grounded Neutral. F. G. Clark. Gives reasons for grounding in the design of a high-tension installation, the reasons for and against the introduction of resistance, and facts relating to the operation. 2000 w. Pro Am Inst of Elec Engrs—Sept., 1907. No. 87721 D.

High Tension.

Recent Italian High-Tension Experiments. Frank C. Perkins. Brief illustrated account of interesting and instructive experiments with pressures ranging from 160,000 volts to 320,000 volts. 1000 w. Prac Engr—Sept. 20, 1907. No. 87330 A.

Line Constants and Abnormal Voltages and Currents in High-Potential Transmissions. Ernst J. Berg. Gives equations for determining these constants, and methods of calculating phenomena by their help. 3500 w. Pro Am Inst of Elec Engrs—Sept., 1907. No. 87718 D.

Losses.

The Losses in Heavy Alternating Current Cables. Abstract translation of an article by E. Stirnimann in the *Elektrotechnische Zeit*, describing experiments on the increased resistance offered to alternating currents by cables of large section. 1000 w. Elec Rev, Lond—Oct. 11, 1907. No. 87830 A.

Minneapolis.

System at Minneapolis for Distributing the Energy Transmitted from Taylor's Falls. Illustrates and describes the provisions made in Minneapolis for receiving and distributing the electrical energy. 1800 w. Elec Wld—Oct. 5, 1907. No. 87486.

Niagara.

The Transmission Plant of the Niagara, Lockport and Ontario Power Company. Ralph D. Mershon. Illustrated detailed description of line construction and stations. 4500 w. Pro Am Inst of Elec Engrs—Sept., 1907. No. 87717 D.

Phase Transformation.

Unbalanced Loads in Two-Phase to Three-Phase Transformation. Bernh. F. Jakobsen. Records a general solution of a problem in phase transformation. 1000 w. Elec Wld—Oct. 12, 1907. No. 87709.

Resistance.

No-Load and Short-Circuit Resistance of Alternating-Current Cables (Leerlauf- und Kurzschlusswiderstand von Wechselstromkabeln). Carl Breitfeld. A mathematical and theoretical discussion. Ills. 4500 w. Elektrotech u Maschinenbau—Sept. 15, 1907. No. 87633 D.

Sweden.

The Tofwehult Westerwik Transmission System, Sweden. Arvid Westerberg. An illustrated article outlining interesting details of an installation for transmitting energy from the waterfall at Tofwehult, where small power is utilized with regard to low charges. 1500 w. Elec Wld—Sept. 28, 1907. No. 87319.

Thury System.

See under Direct Current.

Transformers.

Wiring and Connections for Constant Potential Transformers. George A. Burnham. Diagrams and description of the core-type and shell-type transformers and the electrical connections. 2800 w. Elec Wld—Oct. 5, 1907. No. 87488.

Wire Spans.

Tension and Sag in Wire Spans. Harold Pender. Gives charts devised to obtain a graphical solution of equations deduced by the author in an article published Jan. 12, 1907. 1300 w. Elec Wld—Sept. 28, 1907. No. 87321.

The Suspension of Wires (Ueber den Durchhang von Freileitungen). G. Nicolaus. Discusses particularly telegraph lines, showing the tension which should be placed on the wires to prevent too free swing, with formula. Ills. Tables and

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curves. 3200 w. Serial. 1st part. Elektrotech Zeitschr—Sept. 12, 1907. No. 87658 D.

MISCELLANY.

Electrical Phenomena.

A Presentation of Two Theories of Electrical Phenomena (Deux Théories des Phénomènes Electriques en Présence). P. Harckman. An explanation of the conflicting electronic and ionic theories of electrical phenomena. Ills. 6000 w. Soc Belge d'Elec'ns—Sept., 1907. No. 87600 E.

Insulating Varnishes.

Concerning Insulating Varnishes. A. R. Warnes. Gives results of investigations made to find a reliable insulating varnish. 2500 w. Elec Rev, Lond—Sept. 20, 1907. No. 87337 A.

Possibilities.

The Possibilities of Electrical Development. R. Borlase Matthews. Read before the Birmingham & Dist. Elec. Club. A discussion of the methods that should be employed in England. 6000 w. Elec Engr, Lond—Oct. 11, 1907. No. 87828 A.

INDUSTRIAL ECONOMY

Apprenticeship.

Industrial Education. W. B. Russell. Gives details of the apprentice system of the New York Central lines. 4500 w. Pro Am Soc of Mech Engrs—Oct., 1907. No. 87772.

Cost Determination.

Cost Determining. W. B. Koller. Describes a system of interest to the large as well as the small manufacturer. 1200 w. Ir Age—Oct. 10, 1907. No. 87535.

Higher Costings. Arthur Winder. A criticism of systems of determining costs and an explanation of a better method. 4000 w. Cassier's Mag—Oct., 1907. No. 87389 B.

Education.

College and Apprentice Training. John Price Jackson. Discusses the relation of the student engineering courses in the industries to the college technical courses. 6000 w. Pro Am Soc of Mech Engrs—Oct., 1907. No. 87773 C.

The Russell Sage Laboratory. Rensselaer Polytechnic Institute. Describes the mechanical and electrical equipment. 1500 w. Eng News—Oct. 31, 1907. No. 87986.

The Training of Engineers on the "Sandwich" System. L. D. Coueslant. Explains the working of the apprentice-studentship scheme of the Sunderland Technical College. 2500 w. Engng—Oct. 11, 1907. No. 87837 A.

The Electrotechnic Institute of the Technical University in Carlsruhe (Baden). Stanley P. Smith. Gives a general idea of the curriculum and of the examinations. Ills. 2500 w. Elect'n, Lond—Oct. 11, 1907. No. 87833 A.

The Education of Engineers for Operation and Management in the Technical High Schools of Germany (Die Wirtschaftliche Ausbildung der Maschinen-Ingenieure für Betrieb und Verwaltung an den Technischen Hochschulen Deutschlands). Walter Conrad. 3400 w. Serial. 1st part. Zeitschr d Oest Ing u Arch Ver—Sept. 6, 1907. No. 87644 D.

Electric Railways.

The Electric Railway Situation of Today. Henry J. Pierce. Address before the Street Railway Assn. of the State of N. Y., and the Empire State Gas and Electric Assn. 3500 w. Elec Ry Rev—Oct. 5, 1907. No. 87490.

Mexican Labor.

Present Labor Conditions in Mexico. A. H. Tays. An illustrated article describing the characteristics of the Mexican peon, his mode of life and efficiency as a workman, and the bad results following the raising of wages in Sonoro. 2200 w. Eng & Min Jour—Oct. 5, 1907. No. 87461.

Municipal Ownership.

Municipal Ownership of Public Utilities. John W. Hill. From a paper before the Cent. States W.-Wks. Assn. Arguments opposed to municipal ownership and operation. 3000 w. Eng News—Oct. 10, 1907. No. 87549.

Public Utilities.

Control by State Commissions. Alexander C. Humphreys. From an address at Madison Sq. Garden. N. Y., Oct. 1. Discusses the attempts to reform public service corporations. 2500 w. R R Gaz—Oct. 4, 1907. No. 87922.

See also under Regulation, Railway Engineering, Miscellany.

Shop Management.

See under Management, Mechanical Engineering, Machine Works and Foundries.

Steamship Lines.

The Consolidated Steamship Lines. Information concerning the recent consolidation by Charles W. Morse, of the lines on the Atlantic and Gulf coast. Ills. 1200 w. R R Gaz—Oct. 4, 1907. No. 87925.

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Steel Trade.

Combination and Competition in the Steel Trade. T. Good. A review of the market and of manufacturing conditions in England, Germany, and America. 3500 w. Engineering Magazine—Nov., 1907. No. 87966 B.

Trade Cycles.

Trade Cycles. Herbert Foster. Considers the periodic rise and fall in prices, wages, etc., and gives charts tending to show the operation of a general law. 1500 w. Ir Age—Oct. 24, 1907. No. 87876.

MARINE AND NAVAL ENGINEERING

American Navy.

The American Fleet from an English Point of View. Archibald S. Hurd. Discusses the strength and weaknesses of the American navy. Considers it the second greatest naval force in the world, but lacking in officers and men. Ills. 2500 w. Cassier's Mag—Oct., 1907. Serial. 1st part. No. 87384 B.

Armor.

Modern Armor and Armor-Piercing Projectiles. H. J. Jones. Discusses some of the problems relating to this subject, giving much information. 11000 w. Jour Am Soc of Nav Engrs—Aug., 1907. No. 87767 H.

Battleships.

The Results of the Russo-Japanese War in their Effect on the Further Development of War Ships (Die Ergebnisse der Russisch-Japanischen Seekrieges in ihrer Wirkung auf die Weiterentwickelung im Kriegsschiffbau). G. Neudeck. Ills. 6000 w. Serial. 2 parts. Schiffbau—Sept. 11 and 25, 1907. No. 87630, each D.

Condenser Corrosion.

The Experiments Made by Mr. Uthemann to Discover a Process for Preventing the Corrosion of Copper and Brass by Sea-Water Under the Conditions Found in the Surface-Condensers of Marine Steam-Engines. B. F. Isherwood. Trans. from *Le Génie Civil.* 7000 w. Jour Am Soc of Nav Engrs—Aug., 1907. No. 87761 H.

Electrical Equipment.

See under Mauretania.

Engine Bearings.

Difficulties Experienced with the Main Engine Bearings on Some of Our Latest Vessels. A. F. H. Yates. Gives data collected in the case of five vessels. 9000 w. Jour Am Soc of Nav Engrs—Aug., 1907. No. 87764 H.

Gas Engines.

The Present Status of Marine Gas Engineering. Peter Eyermann. Deals with the internal-combustion engine as at present used in all kinds of services on salt water as well as on fresh-water vessels. Ills. 6500 w. Jour Am Soc of Nav Engrs—Aug., 1907. No. 87762 H.

Gun Mounts.

Comparative Trials of Elevating Gears for Rapid-Fire Gun Mounts. John F. Meigs. An illustrated account of trials. 1500 w. Jour Am Soc of Nav Engrs—Aug., 1907. No. 87763 H.

Hydroplane.

The Crocco and Ricaldoni Hydroplane Boat. Illustrations, with brief description. 500 w. Engng—Oct. 4, 1907. No. 87593 A.

Mauretania.

The Electrical Equipment of the SS. "Mauretania." In this issue the system of power distribution, electrical generating plant, fans, motors for dismantling the turbines, cranes, lifts, etc., are described. 3000 w. Elect'n, Lond—Sept. 27, 1907. Serial. 1st part. No. 87515 A.

Model Basin.

A Brief Description of the Functions and Operation of an Experimental Model Basin. R. H. M. Robinson. Ills. 5000 w. Pro U S Naval Inst—Sept., 1907. No. 87757 F.

Revenue Cutter.

U. S. Revenue Cutter Itasca. Charles S. Root. Describes the U. S. S. Bancroft and its rebuilding and refitting for training cadets of the line and the engineer corps. Ills. 2800 w. Jour Am Soc of Nav Engrs—Aug., 1907. No. 87765 H.

Ship Building.

The Moran Company. H. Cole Estep. Illustrated description and history of this Pacific Coast ship building plant. 2000 w. Marine Rev—Oct. 3, 1907. No. 87436.

Steamboats.

Steamboat Architecture on the Western Rivers. Melville H. Kiel. Illustrates and describes the characteristic features of the boats of the Mississippi and its tributaries. 4000 w. Marine Rev—Oct. 3, 1907. No. 87437

The Steamer Maryland. George Jenkins and A. E. Woodruff. Describes the hull and propelling machinery of a new twin screw steel transfer boat for service between Cape Charles and Norfolk. Ills. 1600 w. Int Marine Engng—Nov., 1907. No. 87806 C.

The Vessel of the Future. Arthur R. Siddell. Considers certain structural re-

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forms for the improvement of large passenger steamers. 2800 w. Int Marine Engng—Nov., 1907. No. 87808 C.

New Swiss Lake Steamers. Trans. from *Zeit. des Ver. deut. Ing.* Illustrates and describes the Blümlisalp for Lake of Thun and the Rhein for the Lake of Constance. 1000 w. Int Marine Engng—Nov., 1907. No. 87807 C.

Steamships.

The Steamships Delaware and Pawnee. Charles S. Linch. Illustrates and describes these latest additions to the fleet of the Clyde Steamship Co. 2000 w. Int Marine Engng—Nov., 1907. No. 87811 C.

See also under Turbine Steamers.

Submarines.

The Progress of the Submarine Boat. Editorial review of the report issued by the Special Board appointed by the United States Navy Department to make tests as to the mechanical efficiency of different types of submarine boats. 2000 w. Engng—Aug. 16, 1907. No. 87363 A.

The Submarine Fleet of France. Brief illustrated descriptions of types of submarines and submersibles belonging to France. 1200 w. Naut Gaz—Oct. 3, 1907. Serial. 1st part. No. 87480.

Suevic.

Repairing the Suevic. Illustrated description of the bow for this White Star liner which was wrecked on a reef off the Lizard. 800 w. Engr, Lond—Sept. 27, 1907. No. 87529 A.

Symington.

William Symington and the Beginnings of Steam Navigation. Robert Cochrane. An illustrated account of his work in the early development of steam navigation. 5500 w. Cassier's Mag—Oct., 1907. No. 87390 B.

Torpedo Boat.

Brazilian Torpedo Boat. Plate, with brief description. 300 w. Engr, Lond—Oct. 4, 1907. No. 87598 A.

Turbine Steamers.

The Turbine Steamship Camden. A. F. H. Yates. Illustrated description of the vessel with report of trials. 1200 w. Jour Am Soc of Nav Engrs—Aug., 1907. No. 87766 H.

Builders' Trials of Curtis Turbine Steamer Creole. Charles B. Edwards. Illustrated description of vessel and equipment, with report of trials. 2500 w. Jour Am Soc of Nav Engrs—Aug., 1907. No. 87768 H.

MECHANICAL ENGINEERING

AUTOMOBILES.

Bearings.

Bearing Castings for Automobiles. E. F. Lake. Remarks on alloys introduced to meet the requirements of the automobile industry, discussing the qualities of the ingredients used in the making of castings for bearings. 3300 w. Foundry—Oct., 1907. No. 87355.

Carbureters.

The Carbureter and Its Functions. Charles E. Duryea. Read before the Soc. of Auto. Engrs. A discussion of the requirements and of the faults of past and present designs, describing the Duryea carbureter. 5000 w. Automobile—Oct. 3, 1907. No. 87413.

Change Gears.

Automobile Change Gears and Their Journals. Henry Hess. Read before the Soc. of Auto. Engrs. An illustrated discussion of how such gears and journals should be designed, and an analysis of the construction of many of the leading types. 3800 w. Am Mach—Vol. 30, No. 44. No. 87976.

Clement.

The 25-35 H.P. Clement Car. The first part describes the engine and the clutch. Ills. 800 w. Autocar—Oct. 5, 1907. Serial. 1st part. No. 87583 A.

Commercial Vehicles.

Motor Cars for Municipal Work. Harry W. Perry. Illustrates various vehicles used for city work, such as gasoline, electric and steam motors for fire apparatus, street sprinklers and sweepers, refuse wagons, police patrol and ambulance, etc. 2300 w. Munic Jour & Engr—Oct. 2, 1907. No. 87383 C.

Swiss Motor Trucks (Schweizerische Motorlastwagen). A. Vogt. The first instalment of the serial illustrates and describes the "Soller" gasoline truck for heavy service. 2000 w. Serial. 1st part. Schweiz Bau—Sept. 28, 1907. No. 87629 B.

Construction.

Future Motor Car Construction. M. C. Krarup. Analyzes the present features and gives a forecast of probable developments. 4500 w. Ir Age—Oct. 10, 1907. No. 87536.

Electromagnetic Control.

Electromagnetic Control of Motor Vehicles. Describes the invention of Arnoldo Paolo Zani, and its application. Diagrams. 1500 w. Elec Engr, Lond—Oct. 11, 1907. No. 87829 A.

Hillman-Coatalen.

The 25 H.P. Hillman-Coatalen Car. Illustrated description. 1200 w. Autocar—Oct. 12, 1907. No. 87821 A.

We supply copies of these articles. See page 559.

Lubrication.

The Nature of Lubrication. Considers the perfectly lubricated bearing, the effect of varying load, and related subjects. 1600 w. Autocar—Oct. 19, 1907. No. 87951 A.

Napier.

The New 30-H.P. Napier Car. Illustrates and describes an interesting model. 1000 w. Auto Jour—Oct. 12, 1907. No. 87820 A.

Pennsylvania.

Type C Pennsylvania "50." Illustrates and describes the distinctive features of the 50 h.p. Pennsylvania car for 1908. 1600 w. Automobile—Oct. 3, 1907. No. 87414.

Pumps.

Idiosyncrasies of Friction-Driven Pumps—Their Prevention and Cure. Considers the troubles that may occur when this means of avoiding overheating is used on motor cars. Ills. 1700 w. Auto Jour—Sept. 28, 1907. No. 87505 A.

The Pittler Rotary Pump and Motor at the Olympia Exhibition. Illustrated detailed description of this rotary engine and its application to an omnibus chassis. 1800 w. Engng—Sept. 27, 1907. No. 87521 A.

Rover.

The Rover Cars. Illustrates and describes the leading characteristics of these cars. 2000 w. Auto Jour—Oct. 5, 1907. Serial. 1st part. No. 87582 A.

Siddeley.

The 30 H.P. Siddeley Car. Illustrated detailed description of this British-built car. 1000 w. Autocar—Sept. 28, 1907. Serial. 1st part. No. 87507 A.

Steering Gears.

The Design of an Automobile Steering Gear. E. W. Graham. Discusses some of the problems to be solved and the details of the design. Ills. 3500 w. Am Mach—Vol. 30, No. 40. No. 87380.

Test.

Test of a White Motor Car at the University of California. Arthur B. Domonoski. Brief description of the car with report of test. 2000 w. Cal Jour of Tech—Oct., 1907. No. 87983.

Tires.

Elastes — Latest Developments. Illustrated description of improvements made in this unpuncturable core for pneumatic tires. 900 w. Auto Jour—Sept. 28, 1907. No. 87506 A.

Valveless.

The 20-H.P. Valveless Car. Illustrated detailed description of an unusual car. 1700 w. Auto Jour—Oct. 5, 1907. Serial. 1st part. No. 87581 A.

Weigel.

The 25-H.P. Weigel Car. Illustrated description of a new model of medium power. 1600 w. Auto Jour—Sept. 21, 1907. No. 87329 A.

COMBUSTION MOTORS.

Exhaust Gases.

On the Gases Exhausted from a Petrol Motor. Prof. B. Hopkinson and L. G. E. Morse. Read before the British Assn., at Leicester. Describes investigations made of the conditions under which carbon monoxide is formed in internal-combustion motors, and related matters. 2500 w. Elec Engr, Lond—Oct. 4, 1907. No. 87587 A.

Gas Cleaning.

Gas Engines. Informal discussion on the best system for cleaning gas to be used in gas engines. Ills. 4000 w. Pro Am Soc of Civ Engrs—Sept., 1907. No. 87713 E.

Gas Engines.

Scope for the Use of Large Gas-Engines for Generating Electric Power in England. Leonard Andrews. Brief discussion giving capital and running cost. 1500 w. Elec Engr, Lond—Oct. 18, 1907. No. 87953 A.

See also under same title under Marine and Naval Engineering; under Central Stations, Electrical Engineering, Generating Stations; under Pumping Plants, Mechanical Engineering, Hydraulics.

Gas Engine Tests.

Researches on the Influence of Mixture Ratio on Gas-Engine Operation (Versuche an der Gasmaschine über den Einfluss des Mischungsverhältnisses). A. Nägel. Illustrates and describes tests made on an 8 horse-power Körting engine and gives results. 13000 w. Serial. 2 parts. Zeitschr d Ver Deutscher Ing—Sept. 7 and 14, 1907. No. 87648, each D.

Gas Producers.

See under Fuels, Steam Engineering.

Gas Turbines.

New Gas Turbine and Centrifugal Air Compressor. Illustrations and information in regard to a new machine on trial in Paris. 1400 w. Sci Am Sup—Oct. 12, 1907. No. 87557.

Governing.

Speed Regulation of Internal Combustion Engines. Explains the method of governing in use on the Diesel crude oil engine. 1500 w. Engr, U S A—Oct. 1, 1907. No. 87327 C.

Ignition.

Contact Method of Gas Engine Ignition. E. J. Edwards. Mathematical discussion of the design of a sparking equipment. 1500 w. Elec Wld—Oct. 19, 1907. No. 87805.

Liquid Fuel.

Liquid Fuel for Internal-Combustion Engines. R. W. A. Brewer. Read before

the Soc. of Engrs. Considers the use of heavy and light oils, vaporization, supply, price, etc. 5500 w. Mech Engr—Oct. 12, 1907. No. 87827 A.

Losses.

Thermal and Power Losses in Internal-Combustion Engines. A. H. Burnand. Describes experimental investigations made. 3000 w. Engng—Oct. 4, 1907. Serial. 1st part. No. 87592 A.

Oil-Engines.

Pumping with Oil-Engines in India. Editorial on the experiments carried out by the Government of Madras to ascertain the actual cost of raising water under different conditions. 1800 w. Engng—Sept. 20, 1907. No. 87344 A.

HEATING AND COOLING.

Blower Systems.

More Data Concerning Fan Heaters. E. T. Child. Reports investigations made of the steam requirements and temperatures obtained in pipe coil heaters. 2000 w. Met Work—Oct. 5, 1907. No. 87434.

See also under Schoolhouses.

Buildings.

Heating and Ventilating the Commercial National Bank Building, Chicago. Plan and detailed description of plant for an 18-story office building. 3500 w. Eng Rec—Oct. 26, 1907. Serial. 1st part. No. 87939.

The Mechanical Ventilation and Warming of St. George's Hall, Liverpool. Charles R. Honiball. Describes an installation for warming and ventilating that has been in successful working since 1851. Ills. 4500 w. Heat & Vent Mag—Oct., 1907. No. 87747.

The Heating and Ventilating Plant of the Post-Office Savings Bank Bureau at Vienna (Die Heizungs- und Lüftungsanlage im k. k. Postsparkassenamtsgebäude in Wien). A. Puppel. Ills. 2700 w. Gesundheits-Ing—Sept. 21, 1907. No. 87639 D.

Charts.

Charts Showing the Performance of Hot-Blast Coils. Burt S. Harrison. With explanatory notes. 700 w. Heat & Vent Mag—Oct., 1907. No. 87748.

Electrical Plant.

The Electrical Heating Plant of the Biltmore Estate. Charles E. Waddell. States the conditions which led to the installation of an electrical plant, giving an illustrated description, and an account of its performance in daily service. 1200 w. Elec Wld—Oct. 5, 1907. No. 87487.

Hot Air.

Improved Hot-Air Heating (Verbesserte Luftheizung). Herr Boehmer. Discusses hot-air heating as applied to small buildings, describing heaters and systems. Ills. 4500 w. Gesundheits-Ing—Sept. 21, 1907. No. 87640 D.

Hotel Ventilation.

Cooling Public Rooms in a Chicago Hotel. Illustrated detailed description of air cooling and ventilating plant for rooms in the Auditorium Annex at Chicago. 3000 w. Ice & Refrig—Oct., 1907. No. 87432 C.

Lecture Halls.

Heating and Ventilating the United States Naval Academy. Showing method of ventilating lecture halls having stepped floors. Ills. 1200 w. Heat & Vent Mag—Oct., 1907. No. 87746.

Schoolhouses.

Blower System of Schoolhouse Heating. Plans, with description. 1500 w. Dom Engng—Oct. 12, 1907. No. 87577.

Steam Heating.

Air Valves for Steam Heating Systems. W. H. Wakeman. The first of a series of illustrated articles giving details of why and where air valves are used. 1800 w. Dom Engng—Oct. 26, 1907. Serial. 1st part. No. 87918.

Heating System of the St. Francis Home, Detroit, Mich. Describes a scheme of heating combining hot blast for public rooms, and direct radiation for smaller rooms and for auxiliary heating. 4500 w. Eng Rec—Oct. 19, 1907. No. 87785.

Temperature Regulator.

Device for Automatically Controlling the Heating of a House. Illustrated description of the "sylphon regitherm," a device invented by Weston M. Fulton, explaining its operation. 1000 w. Sci Am Sup—Oct. 5, 1907. No. 87476.

Tunnel Ventilation.

Ventilation of the Battery Tunnels of the New York Subway Extension to Brooklyn. Plan and description of a system of mechanical ventilation under difficult conditions. The arrangements of the blower stations and the apparatus and duct systems are shown. 3000 w. Eng Rec—Oct. 5, 1907. No. 87444.

HYDRAULICS.

Centrifugal Pumps.

Centrifugal Pumps. E. F. Doty. Explains the necessary elements of the centrifugal pump, briefly reviewing its history and discussing the theory and its relation to present day practice. 2500 w. Engr, U S A—Oct. 1, 1907. No. 87326 C.

High Pressure Centrifugal Pumps (Les Pompes Centrifuges à Haute Pression). André Hallet. Gives a mathematical demonstration of why simple centrifugal pumps are not suitable for high lifts and describes and discusses the designs of several compound systems. Ills. Serial. 1st part. 4500 w. All Indus—Sept., 1907. No. 87607 D.

Dense-Air Pumping.

Operating Reciprocating Steam Pumps

by the Dense-Air System. Snowden B. Redfield. Outlines the advantages and disadvantages of the system, showing under what conditions it will prove economical. 4500 w. Compressed Air—Oct., 1907. No. 87558.

Friction.

See under Civil Engineering, Water Supply.

Pumping.

See under Oil Engines, Mechanical Engineering, Combustion Motors; and under Unwatering, Mining and Metallurgy, Mining.

Pumping Engines.

Prevention of the Short-Stroking of Direct-Acting Duplex Pumping Engines. A. P. Blackstead. An explanation of the different ways this may be accomplished. 600 w. Eng News—Oct. 31, 1907. No. 87989.

Pumping Plants.

A Weber Gas-Power Pumping Plant. Illustrated description of a novel equipment for operating the water and light plant of Rockyford, Colo. 1500 w. Ir Age—Oct. 24, 1907. No. 87877.

Pumps.

Pumps and Pumping Machinery. Joseph H. Hart. Suggestions on the choice of a type for a particular purpose, and the method of installation. 2300 w. Elec Rev, N Y—Oct. 19, 1907. No. 87790.

Sluice Flow.

The Flow of Water Through Sluices. T. E. Thain. Brief discussion of cases and features requiring consideration. 500 w. Prac Engr—Oct. 11, 1907. No. 87826 A.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

Ball and Roller Bearings. J. F. Springer. Discusses the use of separators to reduce friction. 1200 w. Ir Age—Oct. 17, 1907. Serial. 1st part. No. 87737.

Bell Metal.

The Effect of Iron on Bell Metal and a Flux for Introducing It. Charles H. Poland. Describes the writer's experience. 1000 w. Brass Wld—Oct., 1907. No. 87857.

Bevel Gears.

Cutting Bevel Gears with a Rotary Cutter. H. P. Fairfield. Illustrated description of the process of forming the teeth of a bevel gear by milling them with a rotary cutter. 3000 w. Mach, N Y—Oct., 1907. No. 87469 C.

Boiler Making.

Pneumatic Tools for Boiler Shops. Charles Dougherty. Illustrated descriptions with discussion on the design, operation and care. 1500 w. Boiler Maker—Nov., 1907. Serial. 1st part. No. 88000.

Layout of a Large Y Connection. Emmet S. Hegerty. Illustrated description. 1500 w. Boiler Maker—Nov., 1907. No. 87998.

Boring Bars.

A Boring, Reaming, and Facing Bar—How It Was Made. E. John. An illustrated description of how a large bar was made. 1800 w. Am Mach—Vol. 30, No. 44. No. 87979.

Brass Casting.

Methods of Casting Yellow Brass. C. Vickers. Considers the treatment necessary to make yellow brass castings. 1800 w. Foundry—Oct., 1907. No. 87356.

Case-Hardening.

The Case-Hardening of Mild Steel. C. O. Bannister and W. J. Lambert. Read at Vienna meeting of the Ir. & St. Inst. Reports results of investigations made of the microstructure of cemented bars, of the depth of hardness, and a few cases of the carbon content. Micrographs. 1600 w. Ir & Coal Trds Rev—Sept. 27, 1907. No. 87706 A.

Case-Hardening. G. Shaw Scott. Abstract of paper read before the Ir. & St. Inst., at Vienna. An account of research work. 3000 w. Mech Engr, Lond—Sept. 28, 1907. No. 87511 A.

Castings.

The Foundry Department and the Department of Engineering Design. William A. Bole. Notes on the design and manufacture of large and complicated castings. 3800 w. Pro Am Soc of Mech Engrs—Sept., 1907. No. 87429.

Faults of Iron Castings. Forrest E. Cardullo. Considers the causes of blowholes, green sand and dry sand molding, the support of cores, etc. 1800 w. Mach, N Y—Oct., 1907. Serial. 1st part. No. 87468 C.

Cement Plants.

See under Electric Driving, Power and Transmission.

Drop-forging.

Drop-forging Methods and Interesting Work. Describes methods showing difficult forgings and their dies. Ills. 1800 w. Am Mach—Vol. 30, No. 41. No. 87545.

Dust Removal.

Dust Removal in a Brass Foundry. Walter B. Snow. Read at Philadelphia meeting of the Am. Brass Found. Assn. Illustrates and describes mechanical means of removing harmful dust. 2000 w. Heat & Vent Mag—Oct., 1907. No. 87749.

Exhibition.

The Engineering and Machinery Exhibition, Olympia. Joseph Horner. Observations on machines exhibited, with illustrations. 5500 w. Engng—Sept. 27, 1907. Serial. 1st part. No. 87520 A.

We supply copies of these articles. See page 539.

Miscellaneous Exhibits at Olympia. Illustrates and describes types of piston-rings for packing; winding engines for colliery work; steam and gas-engine indicators, etc. 1800 w. Engng—Oct. 18, 1907. No. 87956 A.

Files.

Examining and Testing Files. Oscar E. Perrigo. Considers the properties of files, especially the characteristics of good files, and the methods of testing. 2500 w. Mach, N Y—Oct., 1907. No. 87470 C.

Fly Cutters.

The Fly Cutter as a Reference Gage. An illustrated article showing additional novel uses of the fly cutter. 1000 w. Am Mach—Vol. 30, No. 43. No. 87870.

Foundries.

A Model Pacific Coast Iron Foundry. H. Cole Estep. An illustrated account of the rapid reconstruction of the plant of the Olympic Foundry Co., which was wrecked by a landslide. 1800 w. Foundry—Oct., 1907. No. 87352.

A Foundry for Bench Work. W. J. Keep and Emmet Dwyer. Brief illustrated description of the new foundry of the Michigan Stove Co., Detroit. 1000 w. Pro Am Soc of Mech Engrs—Oct., 1907. No. 87884.

The Iron Foundry of the Firm of H. Bovermann's Successors (Die Eisengiesserei der Firma H. Bovermann Nachf.). Illustrated description of this malleable and gray-iron foundry. 3500 w. Stahl u Eisen—Sept. 4, 1907. No. 87614 D.

Foundry Blower Practice. Walter B. Snow. Considers types of blowers and foundry practice. 6000 w. Pro Am Soc of Mech Engrs—Oct., 1907. No. 87886 C.

Driving a Foundry Fan. Walter J. May. Calls attention to points to bear in mind. 800 w. Prac Engr—Oct. 4, 1907. No. 87584 A.

Foundry Furnaces.

Melting Iron for Foundry Purposes. E. L. Rhead. Deals with appliances for melting. Ills. 2500 w. Mech Engr—Oct. 19, 1907. Serial. 1st part. No. 87952 A.

Foundry Practice.

Melting Iron for Castings. Bradley Stoughton. Discussion of cupola practice, methods of charging and calculating mixtures, tuyere area, fuel, etc. 5300 w. Foundry—Oct., 1907. No. 87351.

Early History of Iron Founding. Robert Buchanan. From a presidential address to the S. Staffordshire Ir. & St. Inst. 4800 w. Ir & Coal Trds Rev—Oct. 4, 1907. No. 87708 A.

Gear Design.

Design of Helical and Herringbone Gears. Charles H. Logue. Explains how helical gears are designed by using simple formulæ and their application to the herringbone gear. 2200 w. Am Mach—Vol. 30, No. 43. No. 87869.

Gears.

Some Memories of English Gears. W. H. Booth. Remarks on early methods of design and the forms and proportions used. 2500 w. Am Mach—Vol. 30, No. 40. No. 87382.

Interference in Involute Gears. C. C. Stutz. Gives a graphical demonstration, formulæ and diagrams. 800 w. Am Mach—Vol. 30, No. 41. No. 87544.

Gear Shaper.

A Novel Gear Shaper. Frank C. Hudson. Illustrates the machine, explaining its working. 700 w. Am Mach—Vol. 30. No. 40. No. 87381.

Grinding.

The Grinding of Woodworking Tools. C. C. Bosworth. Considers the grindstone and other abrasives, their peculiarities and their efficiencies. 3300 w. Woodcraft—Oct., 1907. No. 87402.

Economies and Advantages of Grinding. H. Darbyshire. Considers the selecting of proper wheels, keeping them in good condition, and using them at the right pressure and speed. 4500 w. Am Mach—Vol. 30. No. 42. Serial. 1st part. No. 87736.

Grinding Machines.

A New Universal Grinding Machine. Illustrated description of a machine being shown at the Olympia exhibition. 2200 w. Engr, Lond—Sept. 27, 1907. No. 87531 A.

Universal Grinding Machines (Universal-Schleifmaschine). Illustrated detailed description of machine and methods of use. 4500 w. Serial. 3 parts. Zeitschr f Werkzsugmaschinen u Werkzeuge—Sept. 5, 15 and 25, 1907. No. 87643 each D.

Lathes.

Brummond's Screw-Cutting Lathes. Illustrated description. 2000 w. Engng—Sept. 20, 1907. No. 87343 A.

Reciprocating Attachment for Engine Lathes. E. Beck. Illustrated detailed description. 1400 w. Am Mach—Vol. 30. No. 44. No. 87978.

Five Years' Progress in Engine Lathe Design. Illustrates and describes work of the Lodge & Shipley Machine Tool Co., Cincinnati, O. 1600 w. Ir Age—Oct. 31, 1907. No. 87995.

The Bullard Vertical Turret Lathe. Illustrated description of a machine designed to perform rapidly all kinds of turret lathe chucking work. 4000 w. Ir Age—Oct. 3, 1907. No. 87376.

Lead Scrap.

Tea Lead. Describes the method of the Chinese in the manufacture of tea-lead, and discusses its value as scrap lead. 1100 w. Brass Wld—Oct., 1907. No. 87858.

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Management.

Profit Making in Shop and Factory Management. Charles U. Carpenter. This ninth article of a series discusses the upbuilding of a selling organization. 4500 w. Engineering Magazine—Nov., 1907. No. 87967 B.

The Drafting Room, Its Location and Work. Oscar E. Perrigo. The first of a series on shop management and cost keeping. 3300 w. Ir Trd Rev—Oct. 3, 1907. Serial. 1st part. No. 87405.

Shop Efficiency. H. W. Jacobs. Gives the efficiency records of various workmen where the bonus system has been adopted, giving the results of the system. 1600 w. Am Engr & R R Jour—Oct., 1907. No. 87415 C.

Material Handling.

Overhead Tramrails for the Foundry. A. W. Moyer. Illustrated description of uses made of this labor-saving device in foundry work. 2200 w. Foundry—Oct., 1907. No. 87354.

Milling Machine.

A New Brown & Sharpe Machine Tool. Illustrated description of the No. 3 vertical spindle milling machine with constant speed drive. 1800 w. Ir Age—Oct. 31, 1907. No. 87997.

Molding.

Molding a Cast Steel Runner. H. J. McCaslin. Illustrates and describes the method used. 1800 w. Foundry—Oct., 1907. No. 87353.

Molding a Screw Propeller in Loam. Joseph F. Hart. Illustrates and describes methods used. 1400 w. Am Mach—Vol. 30. No. 43. No. 87871.

Molding Curved Pipe in Dry Sand. Illustrates and describes a method of making curved pipe, vertically, in dry sand. 900 w. Am Mach—Vol. 30. No. 44. No. 87977.

Molding Sand.

Molding Sand. Alexander E. Outerbridge, Jr. Considers the improvement of molding sand by mechanical treatment, and reduction in cost. Ills. 2500 w. Pro Am Soc of Mech Engrs—Oct., 1907. No. 87769.

Paper Making.

See under Electric Driving, Power and Transmission.

Patterns.

Patterns for Repetition Work. E. H. Berry. Discusses requirements and conditions, and details of pattern work. Ills. 7500 w. Pro Am Soc of Mech Engrs—Oct., 1907. No. 87885 D.

Pneumatic Tools.

See under Boiler Making.

Power Values.

Power Values for Machine Tools in Groups. L. P. Alford. Giving the h. p. required for 150 machine tools, showing how these values were obtained. 2000 w. Am Mach—Vol. 30. No. 44. No. 87975.

Roller Bearings.

See under Ball Bearings.

Saws.

Some Circular Saw Kinks and Short Cuts. James F. Hobart. Discusses the adaptability of the common saw table and gives an example of its efficient use for angular work. 1800 w. Wood Craft—Oct., 1907. No. 87403.

Screw Machines.

Speeds and Feeds for Screw Machine Work. C. L. Goodrich and F. A. Stanley. A record of speeds and feeds employed in the automatic screw machine. 1000 w. Am Mach—Vol. 30. No. 41. No. 87542.

Shops.

The Arthur Koppel Company's New Works. Illustrated description of the new plant for the manufacture of portable railways and industrial cars, and its equipment. 2500 w. Ir Age—Oct. 10, 1907. No. 87534.

Soldering.

Experiments on Soldering. Adolf Lippmann. From *Elek. Zeit.* Investigations on the degree of acidity of fluxes and the resulting effect on metals, and the testing of soldering materials. 3300 w. Elec Rev, Lond—Sept. 20, 1907. Serial. 1st part. No. 87336 A.

Speed Changing.

A Variable-Speed and Feed Mechanism. T. M. Lowthian. Illustrated detailed description of a new device for obtaining a multiplicity of changes for either speed or feed gears. 700 w. Am Mach—Vol. 30. No. 42. No. 87735.

Speed-Changing Devices on Machine Tools (Die Umlaufzahlenreihen bei Werkzeugmaschinen). Franz Adler. Illustrated description of various types with a discussion of their design. 8000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—Sept. 21, 1907. No. 87651 D.

Tempering.

The Hardening of Steel. L. Demozay. Read Before the Ir. & St. Inst. at Vienna. Gives an analysis of the part played by the different factors under which the changes in the metal take place. 4500 w. Ir & Coal Trds Rev—Sept. 27, 1907. No. 87704 A.

Vaults.

The Largest Armor Plate Vault. Illustrated description of methods of manufacture at the works of the Bethlehem Steel Co. 1200 w. Ir Age—Oct. 31, 1907. No. 87996.

Worm Gear.

Collier's Ball Worm Gear. W. H. Booth. Illustrated description of a curious form of worm gear devised for the pur-

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pose of a direct drive in automobiles, as well as for a speed-change gear. 1000 w. Am Mach—Vol. 30. No. 42. No. 87734.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

Vanadium Steel. E. F. Lake. Information in regard to the characteristics of a new steel for machine construction. Ills. 1800 w. Mach, N Y—Oct., 1907. No. 87467 C.

Vanadium Steel. Trans. from *Revue Industrielle*. Information concerning vanadium and the characteristics of vanadium steel. 1800 w. R R Gaz—Sept. 20, 1907. No. 87912.

Vanadium Steel. J. Kent Smith. Describes this metal giving its history and its beneficial effects on steel. General discussion. 8800 w. Pro Engrs' Soc of W Penn—Oct., 1907. No. 87861 D.

Boron Steels. Dr. Leon Guillet. Reports micrographic investigations and mechanical tests of normal and quenched case-hardened and annealed steels, giving theoretical and commercial conclusions. Plates. 3000 w. Jour Ir & St Inst—No. II, 1907. No. 87361 N.

Copper Steels. Pierre Breuil. A study of the alloys of iron and copper, the preparation of the ingots, their chemical composition, segregation, treatment; mechanical tests including tensile tests, shock tests on notched and unnotched bars, hardness and torsional tests, with investigation of steels containing 1 per cent of carbon. Ills. 17000 w. Jour Ir & St Inst—No. II, 1907. No. 87357 N.

Cast Iron.

Cast Iron as Cast and Heat Treated. W. H. Hatfield. A report of research work, discussing the decomposition of carbides, the nature of annealing carbon, and the influence of casting temperatures. Plates. 3800 w. Jour Ir & St. Inst—No. II, 1907. No. 87358 N.

Ferro-Alloys.

Special Ferro-Alloys for the Foundry. E. Houghton. Read before the British Found. Assn. Considers ferro-manganese and spiegel, silicon-spiegel, ferro-silicon, ferro-chrome and ferro-phosphorus, giving analyses of blast furnace, and of electrical furnace alloys. 3500 w. Ir & Coal Trds Rev—Sept. 20, 1907. No. 87350 A.

Hardened Steels.

Hardened Steels. Percy Longmuir. Read before the Ir. & St. Inst at Vienna. Indicates briefly some variables in the case of carbon steels. Ills. 1800 w. Mech Engr—Oct. 5, 1907. No. 87585 A.

The Testing of Hardened Steel with Consideration of Spherical Bodies (Prüfverfahren für gehärteten Stahl unter Berücksichtigung der Kugelform). R. Stribeck. Discusses the testing of ball bearings and hardened steels in general, giving results. Ills. 5000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—Sept. 14, 1907. No. 87650 D.

Initial Stresses.

The Stresses Remaining in Metals after Cooling (Ueber Bleibende Spannungen in Werkstücken infolge Abkühlung). E. Heyn. A mathematical discussion of the initial stresses set up in metals during the contraction due to cooling. Ills. Serial. 2 parts. 8000 w. Stahl u Eisen—Sept. 11 and 18, 1907. No. 87615 each D.

Metallography.

Some Micro-Structural Considerations. John Magee Ellsworth and Thomas J. Fay. Extract from paper read before Soc of Auto. Engrs. On the defects revealed by micro-photographs, considering normal and abnormal steels, etc. 3500 w. Automobile—Oct. 17, 1907. No. 87754.

The Researches of G. Cartaud on the Passage of Metals from the Liquid to the Solid State (Les Recherches de G. Cartaud sur le Passage de l'Etat Liquide à l'Etat Solide). F. Osmond. Reviews his published work and the researches left uncompleted at his death. Illustrated by 72 microphotographs. 6700 w. Rev de Métal —Sept., 1907. No. 87603 E + F.

Mild Steel.

Further Experiments in the Ageing of Mild Steel. C. E. Stromeyer. Read at Vienna meeting of the Ir. & St. Inst. Gives tests of steel plates and results, with micrographs, and deductions drawn. 4800 w. Ir & Coal Trds Rev—Sept. 27, 1907. No. 87705 A.

Steel Impurities.

The Non-Metallic Impurities in Steel. E. F. Law. Gives results of observations, considering sulphide of iron, sulphide of manganese, silicate of iron, silicate of manganese and oxide of iron, discussing their effects. Plates. 3700 w. Jour Ir & St. Inst—No. II,. 1907. No. 87359 N.

Tool Steels.

A Study of Hardness in Tool Steels (Etude de la Dureté dans les Aciers à Outils de Tour). M. Demozay. A discussion of the effects of heat treatment on alloy steels of various compositions in their relation to hardness and durability. Ills. 5500 w. Rev de Métal—Sept., 1907. No. 87605 E + F.

MEASUREMENT.

Anemometer.

A Recording Anemometer. J. Rogers Preston. Prize paper read before the Inst. of Heat. & Vent. Engrs., London. Illustrated description. 2000 w. Met Work—Oct. 12, 1907. No. 87572.

Pyrometry.

Optical Pyrometry. Dr. Charles Féry.

Read before the British Assn. Illustrates and describes the Le Chatelier radio-pyrometer as modified by the writer. 1500 w. Engng—Oct. 18, 1907. No. 87961 A.

Steam Flow.

Cylinder Port Velocities. Jacob H. Wallace. Presents a method for determining the velocity of flow through the ports of a steam engine. 1500 w. Pro Am Soc of Mech Engrs—Oct., 1907. No. 87770.

Test Indicator.

Inspecting Tools with the Test Indicator. J. H. Boulet. Illustrates and describes a number of methods of testing and measuring various classes of tools. 1800 w. Am Mach—Vol. 30. No. 42. No. 87733.

Testing Materials.

See under Hardened Steels, Materials of Construction.

POWER AND TRANSMISSION.

Air Compressor.

1,200 Horse-Power Air Compressor. Illustrated description of a plant recently installed at the Seaham Colliery. 1500 w. Engr, Lond—Oct. 11, 1907. No. 87841 A.

Cranes.

Electrical Rolling Mill Transporters. Illustrates and describes electrically driven special transporting devices recently built in Austria. 1800 w. Engr, Lond—Oct. 18, 1907. No. 87965 A.

Notes on Boat and Anchor Cranes. Drawings showing details of electrically operated cranes for handling boats and anchors on warships, representing practice of the past ten years. 1000 w. Int Marine Engng—Nov., 1907. Serial. 1st part. No. 87809 C.

Crane Trolleys.

Formulas for Force Required to Move Crane Trolleys. John S. Myers. Briefly considers the conditions that should be taken into account and the values of factors in the calculations, developing formulæ. 1000 w. Mach, N Y—Oct., 1907. No. 87471 C.

Electrical Equipment in Cement Plants. J. B. Porter. Points out the special advantages of the electric drive in the manufacture of cement both in economy and flexibility. 2500 w. Cement—Sept., 1907. No. 87401 C.

Power Required to Drive Individual Machine Tools. H. B. Emerson. Gives data gathered by the writer. 800 w. Am Mach—Vol. 30. No. 41. No. 87543.

The Electric Driving of Paper Machines (Commande Electrique des Machines à Papier). M. Orban. Discusses the special difficulties in the way of applying electric power to the driving of paper machines, and the manner in which they have been overcome. Ills. 4000 w. Soc Belge d'Elec'ns—Sept., 1907. No. 87601 E.

Elevators.

Electric Elevators. William Baxter, Jr. Illustrates and describes the Cutler-Hammer elevator controller. 1200 w. Engr, U S A—Oct. 1, 1907. No. 87328 C.

Elevators for Industrial Plants. E. R. Carichoff. Brief discussion of the electric, hydraulic and other systems of operation and means of meeting the requirements. 800 w. Elec Rev, N Y—Oct. 26, 1907. No. 87891.

High Speed Elevators. Charles R. Pratt. Describes the type of elevator selected for the new Singer building and the tower of the Metropolitan Life Insurance building in New York, both of which exceed 40 stories. Also short discussion by Orman B. Humphrey. 3000 w. Pro Am Soc of Mech Engrs—Oct., 1907. No. 87771.

Temporary Elevators for the Erection of the Singer Building Tower. Illustrated description of an electrically operated drum elevator with provisions for raising the headworks as needed. 1800 w. Eng Rec—Oct. 12, 1907. No. 87566.

Friction Driving.

Power Transmission by Friction Driving. W. F. M. Goss. An extension of an earlier study of the application of friction wheels to shaft driving. Ills. 6000 w. Pro Am Soc of Mech Engrs—Sept., 1907. No. 87430 C.

Overhead Tramways.

See under Material Handling, Machine Works and Foundries.

STEAM ENGINEERING.

Boiler Furnaces.

Cylindrical Boiler Furnaces. Illustrated review of the development of the modern suspension furnace and the methods of manufacture. 2500 w. Boiler Maker—Oct., 1907. No. 87322.

Boiler Inspection.

Rules for Boiler Inspection. Formulated by the Massachusetts Board of Boiler Rules. 3000 w. Boiler Maker—Nov., 1907. No. 87999.

See also under Railway Engineering, Motive Power and Equipment.

Boiler Management.

Boiler Room Economies. James Smith. This subject is discussed in connection with central-station operation, considering briefly fuel analysis, fuel gas analysis, auxiliary apparatus, feed water, firing, superheating, load factor and radiation. 1200 w. Elec Wld—Oct. 5, 1907. No. 87489.

Boilers.

Novelties in Steam Boilers (Neuerungen auf dem Gebiete des Dampfkessel-

wesens). Illustrates and describes various recent types of boilers, superheating devices, mechanical stokers, etc. 7000 w. Glückauf—Sept. 7, 1907. No. 87624 D.

Condenser Corrosion.

See under Marine and Naval Engineering.

Energy Diagram.

A New Energy Diagram for Steam. Henry F. Schmidt. Presents the advantages of this diagram and the methods used in its construction, giving examples showing its value. Inset. 3500 w. Elec Ry Rev—Oct. 19, 1907. No. 87812.

Engine Design.

Design of Engines for the Use of Highly Superheated Steam. Max E. R. Toltz. An illustrated discussion of the design of steam engines for very high temperatures. 1500 w. Pro Am Soc of Mech Engrs—Sept., 1907. No. 87431.

Engine Foundations.

Engine Foundations. Discusses the preparation of the ground, how to obtain the main center lines of the engine, etc., in the present number. Ills. 1800 w. Prac Engr—Sept. 27, 1907. Serial. 1st part. No. 87508 A.

Engine Speed.

Inertia Pressure at a Rational Measure of Engine Speed. Sanford A. Moss. Aims to show that the magnitude of initial engine pressure is the principal function of the engine speed which needs to be taken into consideration. 2200 w. Sibley Jour of Engng—Oct., 1907. Serial. 1st part. No. 87866 C.

Exhaust Steam.

See under Turbines.

Feed Water.

The Purification of Boiler Feed Water. Louis Waefelaer. Considers methods of treatment and apparatus used, testing, care, etc. Ills. 7000 w. Jour S African Assn of Engrs—Sept., 1907. No. 87950 F.

Fuels.

Steam Production from the Cheaper Grades of Anthracite. William D. Ennis. This second part of the writer's discussion deals with the mechanical problems of air supply, grate and heating surfaces, etc., which affect the economy. 4000 w. Engineering Magazine—Nov., 1907. No. 87970 B.

The Rational Utilization of Low Grade Fuels. F. E. Junge. Discusses how to use inferior coals most efficiently, with special consideration of the application of gas producers. 9800 w. Pro Am Soc of Mech Engrs—Oct., 1907. No. 87883 C.

See also under Locomotive Coals, Railway Engineering, Motive Power and Equipment.

Fuel Testing.

The Fuel-Testing Plant of the United States Geological Survey at Norfolk, Va. Herbert M. Wilson. A report of the work carried out, and description of plant. 3000 w. Eng News—Oct. 10, 1907. No. 87547.

Governing.

The Speed Regulation of Steam Engines. Sterling H. Bunnell. Illustrates and describes various types of governors. 2500 w. Cassier's Mag—Oct., 1907. No. 87388 B.

Governor.

A Balanced Automatic Engine Governor. George P. Hutchins. Illustrated description of the improved design of the American ball governor. 1700 w. Engr, U S A—Oct. 15, 1907. No. 87732 C.

Injectors.

The Injector and Some Requirements for Its Successful Operation. Paul E. Capraro. Explains the principle on which its operation is based, illustrates and describes types, discussing injector troubles and their remedies. 2000 w. Engr, U S A—Oct. 1, 1907. No. 87325 C.

Pumping Engines.

See under same title under Mechanical Engineering, Hydraulics.

Smoke.

The Smoke Problem. David Townsend. Considers the difficulties and the attempted solutions of the smoke problem. 3000 w. Cassier's Mag—Oct., 1907. No. 87391 B.

Practical Smoke Abatement. William Nicholson. Abridged paper, read before the Sanitary Inspectors' Assn. Refers to conditions in London, reviewing action taken to stop unnecessary smoke, and discusses coal smoke, the effects, the cost, practical abatement, smoke from boilers, furnaces, fireplaces, smoke law and its amendment and administration. 3500 w. Elec Engr, Lond—Sept. 29, 1907. Serial. 1st part. No. 87513 A.

Superheating.

See Engine Design, Steam Engineering; and under Superheating, Railway Engineering, Motive Power and Equipment.

Turbines.

A Steam Turbine Economy Test. Reports a test made on a 7,500-kw. Westinghouse-Parsons steam turbine at the Waterside Station, No. 2, of the New York Edison Company. 1200 w. Ir Age—Oct. 10, 1907. No. 87538.

The Sturtevant Steam Turbine. Illustrated detailed description. 900 w. Eng News—Oct. 31, 1907. No. 87985.

Parsons Type Steam Turbines. Charles H. Naylor. A mathematical study of the flow of steam through a turbine of the reaction type. 2500 w. Engr, Lond—Oct. 4, 1907. No. 87599 A.

Some Practical Points in Steam Turbine Construction; with Particular Reference

to the Parsons Type. St. John Chilton. Read before the Am. St. & Int. Ry. Engng Assn. Deals with constructional details. Ills. 3300 w. St Ry Jour—Oct. 19, 1907. No. 87815.

Practical Experience with Exhaust-Steam Turbines. Dr. Alfred Gradenwitz. Illustrates and describes successful applications of low-pressure turbines, using exhaust steam, showing the advantages of the system. 3500 w. Engineering Magazine—Nov., 1907. No. 87969 B.

See also under Central Stations and Turbo-Generators, Electrical Engineering, Generating Stations; and under Turbine Steamers, Marine and Naval Engineering.

Valve-Gear.

Recke-Ruston Positive Valve-Gear. Brief description, with 2-page plate. 600 w. Engng—Sept. 27, 1907. No. 87522 A.

MISCELLANY.

Aeronautics.

The First British Military Airship. Harold J. Shepstone. Illustrations, with description and general information. 1500 w. Sci Am—Oct. 5, 1907. No. 87472.

The Gammeter Orthopter—A Beating-Wing Flying Machine. H. C. Gammeter. Illustrated description. 1000 w. Sci Am—Oct. 12, 1907. No. 87555.

New European Flying Machines. Illustrates and describes a number of machines recently brought out. 1700 w. Sci Am—Oct. 26, 1907. No. 87880.

Aerial Navigation in Marine Service (L'Aeronautica al Servizio della R. Marino). Ettore Cianetti. A discussion of the possibility of using balloons, etc., in naval warfare. 3300 w. Rivista Marittima—Sept., 1907. No. 87662 E + F.

Liquid Air.

The Commercial Liquefaction of Air and the Extraction of Oxygen from the Atmosphere (La Liquéfaction Industrielle de l'Air et l'Extraction de l'Oxygène de l'Atmosphère). E. Mathias. A description of various processes and machines. Ills. 11700 w. Rev Gen des Sciences—Sept. 15, 1907. No. 87606 D.

Minting Machinery.

Minting Machinery. Illustrates and describes machinery made for the Royal Mint, at Ottawa. 8000 w. Engr, Lond—Sept. 27, 1907. No. 87532 A.

Rubber Manufacture.

Manufacture of Mechanical Rubber Goods. An illustrated article describing the reclaiming process, and also the manufacturing methods employed at the Mercer Rubber Co.'s plant in New Jersey. 2500 w. Sci Am—Oct. 5, 1907. No. 87473.

Shock Phenomena.

Character of the Vibrations due to Shock Deduced from an Examination of Fractures (Caractères des Vibrations Accampagnant le Choc Déduits de l'Examen des Cassures). Ch. de Freminville. Ills. 15000 w. Rev de Métal—Sept., 1907. No 87604 E + F.

MINING AND METALLURGY

COAL AND COKE.

Briquetting.

Coal Briquetting in the United States. Edward W. Parker. A report of the present condition of this industry in the different states, illustrating the machines used. 11400 w. Bul Am Inst of Min Engrs—Sept., 1907. No. 87729 D.

British Coalfields.

The Dover Coalfield in England. Edward Walker. An illustrated account of the district and the measures taken to work it. 1800 w. Eng & Min Jour—Oct. 12, 1907. No. 87576.

British Columbia.

A New Coal Field in British Columbia. Arthur Lakes Sketches and description of a valuable field of non-coking lignitic-bituminous coal, near the junction of the Similkameen and Tulameen rivers. 700 w. Min Wld—Oct. 5, 1907. No. 87483.

Coking Qualities.

Why Do Some Coals Coke and Others Not? F. C. Keighley. Read before the Coal Min. Inst. of Am. Considers the influence of geological conditions and physical characteristics of the coal upon coking qualities. 6200 w. Mines & Min—Oct., 1907. No. 87455 C.

Explosions.

Coal-Dust Explosions in Collieries. James Ashworth. Discusses the influence of water and steam on coal dust, as illustrated in the Wingate Grange disaster. Ills. 2800 w. Cassier's Mag—Oct., 1907. No. 87385 B.

The Fire-Damp Explosions at the Reden and Klein-Rosseln Mines in Saarreviere (Die Schlagwetterexplosionen auf den Gruben Reden und Klein-Rosseln im Saarreviere). Friedrich Okorn. Discusses their causes and effects. Ills. 3000 w. Serial. 2 parts. Oest Zeitschr f Berg u Hüttenwesen—Sept. 21 and 28, 1907. No. 87618 each D.

Germany.

The Mining Operations on the Lignite Deposits between Kölzig, Weisswasser, Muskau and Templitz in the Niederlausitz with Special Reference to Their In-

We supply copies of these articles. See page 559.

fluence on the Prevention of Spontaneous Combustion of the Coal (Der Bergwerksbetrieb auf dem Braunkohlenvorkommen zwischen Kölzig, Weisswasser, Muskau und Teuplitz in der Niederlausitz unter besonderer Berücksichtigung seines Einflusses auf die Verhütung der Selbstentzündung der Kohle. Herr Riegel. Ills. 8400 w. Glückauf—Sept. 7, 1907. No. 87621 D.

Handling.

Arrangements for Handling Coal Output. Floyd W. Parsons. Illustrates and describes simple mechanical methods for efficiently handling coal at mines under various conditions. 2200 w. Eng & Min Jour—Oct. 19, 1907. No. 87795.

Longwall Mining.

Mechanical Conveyors as Applied to Longwall Mining. J. I. Thomas. Describes methods and apparatus employed at Vintondale, Pa. 3500 w. Mines & Min—Nov., 1907. No. 87853 C.

Mine Gases.

Mine Gases and Methods of Preventing Explosions. H. E. Gray. Discusses gases found in coal mines, their identification and means for preventing accidents. 3000 w. Eng & Min Jour—Oct. 26, 1907. No. 87897.

Mining.

Coal Mining in Michigan. Lee Fraser. An account of the development and the difficulties, method of mining. etc. Maps. 1600 w. Eng & Min Jour—Sept. 28, 1907. No. 87315.

See also under Longwall Mining.

Mining Plant.

A Modern Illinois Coal Plant. An illustrated description of the surface equipment of Mine B of the Saline County Coal Co., near Harrisburg, Illinois. 2000 w. Mines & Min—Oct., 1907. No. 87453 C.

Peat.

The Utilization of Peat for Power Purposes with the Recuperation of By-products. An article based on five papers by Dr. A. Frank, with letter and editorial. 5000 w. Elec-Chem & Met Ind—Oct., 1907. No. 87502 C.

Organization of the American Peat Society. A report of an organization effected at a meeting at the Jamestown exposition, with abstracts of papers presented. 3000 w. Eng News—Oct. 31, 1907. No. 87993.

Pennsylvania.

Pennsylvania Mines in 1906. An abstract of the report of the Chief of the Department of Mines of Pennsylvania for the year 1906. 4800 w. Mines & Min—Oct., 1907. No. 87460 C.

Rescue Stations.

Underground Rescue or Refuge Stations (Unterirdische Rettungs- bezw. Fluchtstationen). J. Mayer. Discusses the advantages, location, and design of underground stations to serve as places of refuge in case of accident or as working bases in rescue work. 3600 w. Serial. 2 parts. Oest Zeitschr f Berg u Hüttenwesen—Sept. 14 and 21, 1907. No. 87617 each D.

Testing.

See under Fuel Testing, Mechanical Engineering, Steam Engineering.

COPPER.

British Columbia.

The Emma Mine. Frederic Keffer. An account of this low-grade mine of the Boundary District. Ills. 1600 w. Can Min Jour—Oct. 15, 1907. No. 87756.

Converter Hood.

The Laist & Tanner Movable Converter Hood. L. S. Austin. Brief illustrated description of a new invention. 400 w. Min & Sci Pr—Sept. 28, 1907. No. 87410.

Flotation Process.

Concentration Upside Down. Walter Renton Ingalls. Illustrated description of the process of A. P. S. Macquisten which causes sulphide minerals to float while quartz and other gangue minerals sink. 4400 w. Eng & Min Jour—Oct. 26, 1907 No. 87892.

Germany.

Operations and Tendencies of Modern Mansfield. P. A. Wagner and J. S. G. Primrose. An illustrated account of new processes and treatment of ores at these German copper mines. 2200 w. Eng & Min Jour—Oct. 12, 1907. No. 87573.

Mexico.

The Greene Mining Interests in Mexico. Reynolds Coleman. An illustrated account of the valuable copper, gold, and silver properties, and other interests. 18000 w. Min Wld—Oct. 26, 1907. No. 87947.

Montana Deposits.

Copper Deposits of the Belt Formation in Montana. M. Collen. Describes the geology of this region and gives the writer's views in regard to the genesis of the copper ores. 1200 w. Ec-Geol—Sept., 1907. No. 87899 D.

Moss Copper.

Moss Copper on Matte. E. L. Larison. Describes the Ducktown, Tenn., mattes and the formation of metallic copper, giving information in regard to the mosses. 800 w. Min Wld—Oct. 5, 1907. No. 87484.

Nevada.

The Copper Mines of Ely, Nevada. Walter Renton Ingalls. Gives the history, geology and general mining conditions of the district. Ills. 6500 w. Eng & Min Jour—Oct. 12, 1907. No. 87574.

The Productive and Earning Capacity of Ely. Walter Renton Ingalls. An illus-

trated account of this property which has an assured production for many years. Much of the copper will be produced for 7 cents per pound. 3000 w. Eng & Min Jour—Oct. 19, 1907. No. 87791.

Ore Deposits.

Origin of Copper Impregnations in Sedimentary Rock. H. E. Blake. Refers to an article by Prof. Arthur Lakes on this subject, and gives the writer's explanation. 1000 w. Min Rept—Oct. 17, 1907. No. 87800.

Precipitation.

Precipitation of Copper from Chloride Solutions by Means of Ferrous Chloride. Gustave Fernekes. Gives analyses of mine waters, and an experimental study of copper precipitation therefrom. 1500 w. Ec-Geol—Sept., 1907. No. 87900 D.

Sheet Copper.

The Rolling of Sheet Copper. Describes the characteristics of sheet copper mills, and the general methods. 3800 w. Met Work—Oct. 5, 1907. No. 87435.

Smelters vs. Producers.

I. The Mutual Relations and Grievances of the Smelting Trust and the Ore Producer. E. M. de la Vergne. Discusses the wrongs and remedies. II. A Response to the Address of Senator E. M. de la Vergne. Franklin Guiterman. Also general discussion. 12000 w. Am Min Cong—1906. No. 87368 N.

Smelting.

Copper Smelting in Utah. Robert B. Brinsmade. Illustrates and describes the practice at the Utah Consolidated, the Bingham Consolidated, and the Yampa smelters. 5500 w. Mines & Min—Nov., 1907. No. 87849 C.

Washoe Reduction Works at Anaconda, Montana. Describes the McDougal roasters, the large reverberatory smelters, and the utilization of waste heat. 1600 w. Mines & Min—Oct., 1907. No. 87459 C.

Smelting Works of the Consolidated Mining and Smelting Company of Canada, Limited, at Trail, B. C. J. M. Turnbull. Illustrated description of the plant and its equipment. 3000 w. Can Min Jour—Oct. 1, 1907. No. 87438.

Washington.

Copper Deposits of Washington. Albert W. McIntyre. Gives information which indicates the presence of copper deposits of value. 6000 w. Am Min Cong—1906. No. 87373 N.

GOLD AND SILVER.

Assaying.

The Effect of High Litharge in the Crucible-Assay for Silver. Richard W. Lodge. Shows that the use of a large excess of litharge in the assay of some ores will give results for silver that are uneven as well as low. 1200 w. Bul Am Inst of Min Engrs—Sept., 1907. No. 87724 C.

Chlorination.

Chlorination of Gold-Ores; Laboratory Tests. A. L. Sweetser. Detailed description of laboratory tests in connection with the chlorination process. 2500 w. Bul Am Inst of Min Engrs—Sept., 1907. No. 87726 C.

Comstock Lode.

The Great Comstock Lode. G. McM. Ross. Outlines the history of the discovery and development of this mining district and the output of gold and silver. 3000 w. Min & Sci Pr—Oct. 12, 1907. No. 87753.

Cyaniding.

Recent Improvements in the Cyanide Process. F. L. Bosque. Reviews the development of the process and recent advances. 3000 w. Am Min Cong—1906. No. 87366 N.

Recent Advance in Cyanidation in Mexico. J. Leslie Mennell. Gives an account of the increasing use of this process for the extraction of gold and silver. 2500 w. Min Wld—Oct. 26, 1907. No. 87943.

The Cyanide Process at the Portland (Colo.) Mill. Regis Chauvenet. General remarks on the history of this process, describing the present practice at this mill. 2200 w. Min Rept—Oct. 24, 1907. Serial. 1st part. No. 87920.

Distribution.

The Geological Distribution of Gold. T. A. Rickard. Considers the relation of geology to the gold industry, some mistakes made, recent advances, etc. 4000 w. Am Min Cong—1906. No. 87371 N.

Goldfield District.

The Combination Mine. Edgar A. Collins. The present number gives an account of the early development and the geologic structure of this Nevada mine. Ills. 2500 w. Min & Sci Pr—Sept. 28, 1907. Serial. 1st part. No. 87409.

Mexico.

Mines of the Taviche District, Oaxaca, Mexico. A. E. Place and H. L. Elton. Describes these mines, and the veins bearing the silver sulphide ores, which are remarkably free from faulting and usually appear at the surface. 1500 w. Eng & Min Jour—Oct. 5, 1907. No. 87462.

Milling.

The Milling Practice at El Oro Mine, Mexico. E. Burt. Describes the treatment and the tube mills. Ills. 2500 w. Min Wld—Oct. 26, 1907. No. 87945.

The Desert Mill. A. R. Parsons. Detailed description of 100-stamp mill and power-plant at Millers, Nevada, for milling ores from the Tonopah mines. Ills. 4500 w. Min & Sci Pr—Oct. 19, 1907. No. 87889.

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Nevada.

The Osceola Gold District of Nevada. Gives the history and a description of this district. Ills. 1600 w. Min Rept—Oct. 3, 1907. No. 87501.

Nile.

The Nile as a Mining River. Alexander Del Mar. Reviews the ancient history of mining in this region. 3800 w. Min & Sci Pr—Oct. 12, 1907. No. 87752.

Nova Scotia.

The Development of an Ore Shoot in Nova Scotia. E. Percy Brown. Gives an outline of the history of the Brookfield mine. 1600 w. Can Min Jour—Oct. 15, 1907. No. 87755.

Gold Measures of Tangier, Nova Scotia. George A. Packard. Describes characteristics of a district where the mines have been worked by small owners, or lessees. Ills. 2000 w. Min & Sci Pr—Oct. 5, 1907. No. 87540.

Placers.

Cause of Fine Gold in San Juan River, Utah. A. Lakes. Explains the probable origin of the gold and the cause of its extreme fineness. 900 w. Min Rept—Oct. 3, 1907. No. 87500.

Rand.

Working Costs of the Mines of the Witwatersrand. Discussion by R. N. Kotzé, of the paper by Ross E. Browne. 5500 w. Jour S African Assn of Engrs—Aug., 1907. No. 87504 F.

Servia.

Gold in Eastern Servia. Douchan Ivanovitch. Abstract translation. Brief account of this region, the geology, mineralogy and the mining industry. 1600 w. Min Jour—Oct. 5, 1907. No. 87591 A.

Slimes Treatment.

Recent Improvement in Slimes Treatment. D. J. Kelly. Read before the W. Assn, of Tech. Chem. & Met. Describes methods of filtration used for separating the gold solutions from slimes. 4500 w. Mines & Min—Oct., 1907. No. 87454 C.

IRON AND STEEL.

Austria.

The Austrian Iron Industry. Wilhelm Kestranek. Read before the Ir. & St. Inst., at Vienna. Reviews the history of the industry during the last twenty-five years. 4000 w. Engng—Sept. 27, 1907. No. 87523 A.

Austrian Deposits.

The Erzberg of Eisenerz. H. Bauerman. Read before the Ir. & St. Inst., at Vienna. Describes this ore mountain of the Eastern Alps, and its deposits, especially the iron ore workings. 2800 w. Engng—Sept. 27, 1907. No. 87524 A.

Blast Furnaces.

Address on the Effect of Air and Moisture on Blast-Furnaces. Joseph Dawson. Reprint of an address at meeting of ironmasters on June 11, 1800. 7500 w. Jour Ir & St Inst—No. II, 1907. No. 87362 N.

Blow-Holes.

Blow Holes in Steel Ingots. E. von Maltitz. Gives the writer's views and experience in regard to the formation of blow-holes, their prevention, and related matters. 14600 w. Bul Am Inst of Min Engrs—Sept., 1907. No. 87722 D.

Charcoal-Iron.

A By-Product Charcoal-Iron Plant at Marquette, Mich. Plan and description. 2500 w. Eng Rec—Oct. 12, 1907. No. 87571.

Laboratory.

The Creation of a Laboratory for a Modern Ironworks (Wie muss das Hauptlaboratorium eines Neuzeitlichen Eisenhüttenwerks Beschaffen sein). August Kaysser. Discusses the various departments necessary, the work to be done in each, apparatus, etc. Ills. 5300 w. Serial. 2 parts. Stahl u Eisen—Sept. 11 and 18, 1907. No. 87616 each D.

Lake Superior.

Developments in the Menominee Range. An illustrated account of the mines of this Lake Superior district and their equipment. 2200 w. Ir Trd Rev—Oct. 17, 1907. No. 87750.

Lapland Ores.

The Geology and Origin of the Lapland Iron Ores. Dr. O. Stutzer. Describes the geology of Lapland, and considers the more important occurrences of iron ore, discussing their origin. Plates and bibliography. 32000 w. Jour Ir & St Inst—No. II, 1907. No. 87360 N.

Metallurgical Chemistry.

Application of the Laws of Physical Chemistry in the Metallurgy of Iron. Baron H. von Juptner. Read before the Ir. & St. Inst. at Vienna. Deals with the doctrine of chemical equilibrium as applied to metallurgical chemical processes. 5800 w. Ir & Coal Trds Rev—Sept. 27, 1907. No. 87703 A.

Meteoric Iron.

Steel and Meteoric Iron. Prof. Frederick Berwerth. Read before the Ir. & St. Inst. at Vienna. Aims to show in a general way that meteoric iron and steel works steels are results of essentially similar chemical and physical causes. 3500 w. Engng—Oct. 4, 1907. No. 87594 A.

Minnesota.

The Cuyuna Iron Range. Newton H. Winchell. Describes the geological structure. 2500 w. Ec-Geol—Sept., 1907. No. 87898 D.

Iron Ore in Crow Wing County, Minn. Dwight E. Woodbridge. An account of recent discoveries of merchantable ore.

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1500 w. Eng & Min Jour—Oct. 26, 1907. No. 87894.

Smelting.

Zinc Oxide in Iron-Ores, and the Effect of Zinc in the Iron Blast-Furnace. John J. Porter. Explains the difficulties that arise from the presence of zinc. 2500 w. Bul Am Inst of Min Engrs—Sept., 1907. No. 87725 C.

Steel Works.

The Forges and Mines of the Hungarian State. Plan and illustrated description of the Diosgyor steel works, their equipment, management, etc. 6000 w. Engr, Lond—Sept. 20, 1907. No. 87347 A.

The Krupp Works in Germany. J. B. Van Brussel. An illustrated description of a group of plants comprising blast furnaces, steel mills, gun and armor plate shops. 4000 w. Ir Trd Rev—Oct. 3, 1907. No. 87404.

Trade.

See under Steel Trade, Industrial Economy.

MINING.

Accidents.

The Prevention of Mine Accidents. Edward W. Parker. Remarks on the dangers, especially in coal mining, and the need of some action in the United States to correct the abuses and causes. 2000 w. Am Min Cong—1906. No. 87372 N.

Prevention of Accidents in Mines. P. J. Slevin. Read before the Connellsville Min. Inst. Discusses some causes of accidents and means for guarding against them. 2200 w. Mines & Min—Oct., 1907. No. 87456 C.

Australia.

Mining in Australia. W. J. Loring. Deals with the states in order, giving a description of present mining conditions. 2000 w. Min & Sci Pr—Oct. 19, 1907. No. 87890.

Boring.

The Theory of the Movement of the Flushing Stream in Bore Holes (Die Theorie der Bewegung des Spülstromes in Bohrlöchern). Richard Sorge. A theoretical and mathematical discussion. Ills. 7000 w. Glückauf—Sept. 28, 1907. No. 87626 D.

Cage Guides.

The Arrangement of Cage Guides for Modern Collieries. J. S. Barnes. Drawings with description of working details of both rope and steel rail guides for winding coal at high speeds and heavy loads. 2500 w. Ir & Coal Trds Rev—Oct. 4, 1907. No. 87707 A.

Canada.

Canadian Mining Intelligence. H. Mortimer Lamb. Discusses briefly the mineral production of British Columbia, the gold output of Nova Scotia, the Canadian mint, and gold dredging on the Saskatchewan. 2500 w. Mines & Min—Oct., 1907. No. 87458 C.

Concentration.

Milling Practice at the Granadena Mill. S. F. Shaw. Describes the method of treatment of the complex ore from this Mexican mine. Ills. 1200 w. Eng & Min Jour—Oct. 5, 1907. No. 87465.

Tails and Sludge Milling at the Old Judge Mine, Oronogo, Mo. W. D. Glenn. Describes a new method of treatment, equipment, and pulp flow. 1000 w. Mines & Min—Nov., 1907. No. 87845 C.

Mill Building Progress in the Joplin District. Claude L. Watson. Illustrated detailed description of the Oakwood mill, Webb City, Mo. 1500 w. Mines & Min—Nov., 1907. No. 87844 C.

Damage Litigation.

Recent Litigation Involving Questions of Alleged Damage from Tailings, Tailings Waters, and Smelter Fumes. Prof. F. W. Traphagen. Reviews cases before the courts of Montana and the investigations made by experts. 1500 w. Am Min Cong—1906. No. 87374 N.

Diamond Drilling.

The Diamond Core-Drill in Prospecting. Lewis T. Wright. Presents some of the advantages and disadvantages. 2000 w. Min & Sci Pr—Oct. 12, 1907. No. 87751.

Drainage.

Draining the Panther Creek Basin. H. H. Stoek. Illustrated description of tunnel 13 miles long for draining the mines of the Lehigh Coal and Navigation Co. 2200 w. Mines & Min—Nov., 1907. No. 87846 C.

Drainage Districts.

Mine Drainage Districts. D. W. Brunton. Introductory to a discussion of the question of creating mine drainage districts, followed by discussion. 7000 w. Am Min Cong—1906. No. 87367 N.

Electric Hoisting.

The Electric Hoist at the Hermann Mine at Eisleben (Die Elektrische Fördermaschine auf "Hermannschacht" bei Eisleben). L. Hoffmann. Illustrates and describes an installation on the Ilgner system. 1800 w. Glückauf—Sept. 7, 1907. No. 87625 D.

Some New Flywheel Storage Systems. A. P. Wood. Read before the Manchester Sec. of the Inst. of Elec. Engrs. Describes some recent patents in connection with electric winding plants, discussing the three-phase system, the cascade flywheel storage system, and others. Ills. 3800 w. Elec Engr, Lond—Sept. 20, 1907. No. 87334 A.

We supply copies of these articles. See page 559.

Electrical Machinery.

Fire and Explosion-Proof Electrical Mining Machinery. Briefly considers switchgear, motors, motor controlling resistances, transformer and switch oil, etc. 2500 w. Elec Rev, Lond—Sept. 20, 1907. No. 87335 A.

Explosives.

Explosives in Coal Mines. E. J. Deason. A review of the British regulations of the past ten years and of the Woolwich tests. Ills. 6500 w. Ir & Coal Trds Rev—Sept. 20, 1907. No. 87349 A.

The Testing of Safety Explosives (Ueber die Prüfung von Sicherheitssprengstoffen). Herr Beyling. Discusses the composition of the various classes of safety explosives, the conditions they should fulfil and methods of testing. Tables. 6000 w. Glückauf—Sept. 7, 1907. No. 87620 D.

Haulage.

Construction of Tracks in Coal Mines. M. S. Hachita. Urges that more attention be given to building haulage roads, the laying out of frogs, switches, etc. 3500 w. Eng & Min Jour—Oct. 5, 1907. No. 87466.

Self-Acting Endless-Rope Haulage at the Glückhilf Mine at Hettstedt (Bremsbergförderung mit Seil ohne Ende auf "Glückhilfschächte" bei Hettstedt). L. Hoffmann. Illustrates and describes the haulage installation, signals, etc. 1600 w. Glückauf—Sept. 7, 1907. No. 87622 D.

Hoisting.

Transvaal Commission Report on the Use of Winding Ropes and Safety Appliances in Pit Shafts. Abstract. 11000 w. Ir & Coal Trds Rev—Oct. 11, 1907. No. 87842 A.

Report of the Transvaal Commission on the Use of Winding Ropes, Safety Catches and Appliances in Mine Shafts. An important statement in regard to safe practice in deep mine hoisting. The full report will be given. 6000 w. Eng News —Oct. 31, 1907. Serial. 1st part. No. 87988.

The Use of Winding Ropes, Safety Catches, and Appliances in Mine Shafts. Abstract of the report of commission appointed by the Governor of the Transvaal to investigate this subject. 4800 w. Col Guard—Sept. 27, 1907. Serial. 1st part. No. 87519 A.

See also under Electric Hoisting.

Joplin District.

The Joplin Zinc District. R. L. Herrick. An illustrated general description of the mining and milling methods in use in the region. Plate. 12000 w. Mines & Min—Nov., 1907. No. 87843 C.

The Yellow Dog Mine and Mill. R. L. Herrick. Illustrated general description of methods of mining sheet ground, hoisting by endless conveyor, and methods of milling at Webb City, Mo. 2000 w. Mines & Min—Nov., 1907. No. 87847 C.

Handling "Sheet-Ground" in the Joplin District. J. H. Polhemus. Illustrates and describes methods of mining and milling as practiced by the American Zinc, Lead, and Smelting Co. 2000 w. Mines & Min—Nov., 1907. No. 87848 C.

Mining in the Joplin District. Ch. Guengerich. Brief account of conditions in this region which furnishes 50 per cent of the zinc ore smelted in the United States. 1800 w. Am Min Cong—1906. No. 87369 N.

See also under Concentration.

Magnetic Separation.

The Separation of Tin-Oxide from Wolfram. Amos Treboar and Gurth Johnson. Brief account of experimental work . 600 w. Inst of Min & Met, Bul. 36—Sept. 19, 1907. No. 87560 N.

Metal Mining.

The Development of the Metal Mining Industry in the Western States. Waldemar Lindgren. An outline of the gold and silver mining, considering placer mining, gold-quartz mining, silver mining, reduction works, etc. 5000 w. Am Min Cong —1906. No. 87364 N.

Mine Signals.

Electric Signal System for Mines. Carl L. C. Fichtel. Illustrates and describes a new system installed in some of the copper mines of the Lake Superior region. 900 w. Eng & Min Jour—Oct. 26, 1907. No. 87893.

Open-Cut.

Nickel Mining in New Caledonia. G. M. Colvocoresses. Describes the methods of mining nickel ores from large and small open workings or quarries on the sides of the mountains, and the method of handling the ore. Ills. 4000 w. Eng & Min Jour—Sept. 28, 1907. No. 87314.

Ore Feeders.

Notes on Feeders, with a Description of a New Driving Device. D. J. Pepler. Describes Pepler's Operative Device to Challenge Feeder. 1500 w. Jour Chem, Met, and Min Soc of S Africa—Aug., 1907. No. 87823 E.

Pumping.

See under Unwatering.

Shaft Sinking.

Shaft Sinking by the Freezing Process. Sydney F. Walker. Describes the vertical pipe method used in England, and a new ring process employed in Germany. 4500 w. Eng & Min Jour—Oct. 12, 1907. No. 87575.

Care of the Plant in Sinking by Refrigeration. Sydney F. Walker. Causes of interruptions in the operation of this system are discussed, and methods of

correcting them. 2500 w. Eng & Min Jour—Oct. 26, 1907. No. 87895.

The Hydraulic Shaft Borer (Der Hydraulische Schachtbohrer). Herr Schlüter. Describes a device for boring full-size shafts, with details of power requirements, labor, costs, etc. Ills. 5300 w. Glückauf—Sept. 7, 1907. No. 87619 D.

Timbering.

Re-timbering the Kearsarge Shaft. Lee Fraser. Describes work made necessary by a fire. Sections. 700 w. Min & Sci Pr—Oct. 5, 1907. No. 87541.

Unwatering.

Unwatering by Means of an Inclined Skip. Douglas Muir. States the conditions and describes the work. Ills. 900 w. Eng & Min Jour—Oct. 19, 1907. No. 87793.

Unwatering Plant for the Lindal Moor Mines. Illustrated description of the pumping plant for unwatering these iron mines. 1500 w. Engng—Oct. 11, 1907. No. 87838 A.

See also under Drainage.

Ventilation.

Deficiencies in Mine Ventilation. Thomas A. Mather. Read at Min. Inst. at Latrobe, Pa. The causes are discussed and the relative degrees of responsibility of the different people contributing to ventilation. 2800 w. Mines & Min—Oct., 1907. No. 87457 C.

MISCELLANY.

Alaska.

Alaska and Its Possibilities. J. T. Cornforth. Brief account of placer gold districts, other minerals found, and matters relating to the development of the country. 1500 w. Am Min Cong—1906. No. 87375 N.

Arsenic.

The Arsenic Industry of Cornwall. Illustrated description of the process of manufacture. 2000 w. Sci Am Sup—Oct. 5, 1907. No. 87475.

Asbestos.

The Asbestos Industry of Quebec. Ralph Stokes. Illustrates and describes the mines and quarries in the present article. 2200 w. Min Wld—Oct. 19, 1907. Serial. 1st part. No. 87801.

Asia.

A Journey to Central Asia. A. Adiassewick. General description with special reference to the great mineral wealth. 11000 w. Inst of Min & Met, Bul. 36—Sept. 19, 1907. No. 87559 N.

Blow-outs.

The Blow-out. F. Lynwood Garrison. Illustrates and describes interesting geological formations of this character in Arizona and Nevada. 800 w. Min & Sci Pr—Sept. 28, 1907. No. 87412.

Borax.

Death Valley Borax. O. M. Boyle, Jr. Brief account of the deposits and the condition of the industry. Ills. 1200 w. Cal Jour of Tech—Sept., 1907. No. 87428.

Cement.

Advances in Cement Technology, 1906. Edwin C. Eckel. Considers the growth of the cement industry, kilns and kiln practice, and matters related. 3500 w. Cement—Sept., 1907. No. 87399 C.

Statistics of Cement Industry in 1906. L. L. Kimball. Considers the general conditions, the production, with report by states. 7000 w. Cement—Sept., 1907. No. 87400 C.

Chloride Process.

A New Application of Chlorine in Metallurgy. Charles E. Baker. Read at N. Y. meeting of the Am. Elec.-Chem. Soc. Deals with the manner of treating sulphide ores. 1800 w. Min Rept—Oct. 24, 1907. No. 87919.

Diamonds.

Diamonds in the United States. Douglas B. Sterret, in Mineral Resources of the U. S., 1906. Describes a discovery by M. J. Cooney, on the Feather River, California, and other finds on record. 1200 w. Min Rept—Oct. 10, 1907. No. 87578.

Kimberlite Dykes and Pipes. Dr. F. W. Voit. Read before the Geol. Soc. of S. Africa. Describes peculiarities of these diamond mines, studying the origin of the dykes and pipes, and the character of the rock. 2500 w. Min Jour—Sept. 21, 1907. Serial. 1st part. No. 87341 A.

Exhibition.

Minerals at the Jamestown Exposition. Joseph Struthers. An illustrated brief description of the exhibits of the different states. 4000 w. Eng & Min Jour—Oct. 19, 1907. No. 87794.

Leadville.

Genesis of the Ores of Leadville. S. F. Emmons. Abstracted from Bul. of the U. S. Geol. Surv. A study of geological formation and the ore deposits of this region. 5500 w. Min & Sci Pr—Sept. 28, 1907. No. 87411.

Lime Analysis.

Notes on the Estimation of Caustic Lime. Edw. H. Croghan. Facts obtained during a series of tests and analyses on certain burnt limes. 4000 w. Jour Chem, Met, & Min Soc of S Africa—Aug., 1907. No. 87822 E.

Mexico.

The History of Mining Developments in Mexico. T. C. Graham. Brief review. 2500 w. Min Wld—Oct. 26, 1907. No. 87946.

Mexico: Its Geology and Natural Resources. Robert Thomas Hill. An interesting illustrated study of the geology,

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mineralization, etc. 5000 w. Min Wld—Oct. 26, 1907. No. 87942.

The Economic Progress of Mexico Since Early Times. Charles C. Schnatterbeck. Illustrated historical review. 8000 w. Min Wld—Oct. 26, 1907. No. 87940.

Some Notes on a Journey Through Mexico. Dwight E. Woodbridge. Illustrated description of the country, its transportation facilities, etc. 4000 w. Min Wld—Oct. 26, 1907. No. 87944.

Traveling on the West Coast of Mexico. Dwight E. Woodbridge. Illustrated description of the region and of the business and mining conditions. 3500 w. Eng & Min Jour—Oct. 5, 1907. No. 87463.

Mineral Resources on Kansas City, Mexico & Orient Railway. James W. Malcolmson. Extract from a recent report of this railway, describing the mines in Mexico. 2500 w. Min Wld—Oct. 26, 1907. No. 87948.

Characteristics of Some Mexican Mining Regions. Robert T. Hill. Discussion of relationships between geographic features and economic resources in Chihuahua, Sonora, and Western Sierra Madre. Ills. 3500 w. Eng & Min Jour—Oct. 5, 1907. No. 87464.

See also under Tin; and under Mexican Labor, Industrial Economy.

Monazite.

The Mining of Monazite. Douglas B. Sterrett. Describes methods of working the deposits of this thorium mineral. 2000 w. Sci Am Sup—Oct. 19, 1907. No. 87744.

Nickel.

The Occurrence of Nickel in Virginia. Thomas Leonard Watson. Describes in some detail these nickeliferous pyrrhotite deposits at the Lick Fork openings. Maps. 4000 w. Bul Am Inst of Min Engrs—Sept., 1907. No. 87730 C.

Nitrogen.

A New System for the Fixation of Atmospheric Nitrogen. F. Savorgnan di Brazza. Illustrates and describes a process based upon the property of calcium carbide to fix nitrogen at high temperatures. 1500 w. Sci Am—Oct. 12, 1907. No. 87554.

Oil Fields.

Oil Field on Buffalo Creek, West Virginia. Frank W. Brady. Information in regard to the location of wells, methods and production. Ills. 2700 w. Mines & Min—Nov., 1907. No. 87851 C.

Economic and Technical Notes on the Wietze Petroleum District (Wirtschaftliche und Technische Mitteilungen über den Wietzer Erdölbezirk). Herr. Dobblestein. Describes the oil-wells, methods, etc., and gives statistics of production of this most important oil district in Germany. Ills. 3500 w. Glückauf—Sept. 7, 1907. No. 87623 D.

Ore Deposition.

The Interaction Between Minerals and Water Solutions, with Special Reference to Geologic Phenomena. Eugene C. Sullivan. Describes work undertaken in the chemical laboratory of the U. S. Geol. Survey, in an attempt to apply chemical methods to the investigations of geologic processes, especially of the secondary deposition of ores. 4000 w. Min Jour—Sept. 21, 1907. Serial. 1st part. No. 87340 A.

Peru.

The Mineral Wealth of the Province of Santiago de Chuco, Peru. F. Málaga Santolalla. Describes this region of the Andes, and the deposits of silver, copper, lead, and other minerals. 3000 w. Min Jour—Sept. 28, 1907. Serial. 1st part. No. 87518 A.

Petroleum.

The International Petroleum Congress. David T. Day. An account of the gathering of petroleum experts and chemists, and the progress of the industry, especially in Roumania. Ills. 2200 w. Eng & Min Jour—Oct. 26, 1907. No. 87896.

Radium.

A New Mineral Industry—The Manufacture of Radium. Jacques Loyer. An illustrated outline of the methods used at Nogent-sur-Marne. 1800 w. Engineering Magazine—Nov., 1907. No. 87971 B.

Rocky Mountains.

Certain Features of the Rocky Mountain Region. Horace F. Evans. Describes the general features of the Rocky Mountain systems, especially north of the 49th parallel. 1800 w. Min Wld—Oct. 19, 1907. Serial. 1st part. No. 87802.

Sakhalin.

The Mineral Resources of the Island of Sakhalin. Reviews the history and the characteristics of the political situation, geographical and geological features and present conditions, discussing the useful mineral deposits and their importance. Ills. 3500 w. Min Jour—Sept. 28, 1907. No. 87517 A.

Smelting Regulations.

German Smelting Regulations. Gives regulations pertaining especially to zinc smelters. 1200 w. Min Rept—Oct. 17, 1907. No. 87798.

Tantalum.

Tantalum. Abstract translation of an article by Paul Nicolardat in *Revue Scientifique*, on the properties of this metal. 2000 w. Sci Am Sup—Oct. 5, 1907. No. 87478.

Tin.

The Tin Deposits of Mexico. H. G.

We supply copies of these articles. See page 559.

Bretherton. Describes the Paso de Sotos district. 1000 w. Min Wld—Oct. 26, 1907. No. 87941.

Tin Mining in Siam. K. Van Dort. An illustrated account of the methods of mining and working. 3000 w. Eng & Min Jour—Oct. 19, 1907. No. 87792.

A Review of the World's Tin-Mining Industries. A. Selwyn-Brown. Information relating to the production, sources, mining conditions and prospects. 4000 w. Engineering Magazine—Nov., 1907. No. 87973 B.

Geology and Mining of the Tin-Deposits of Cape Prince of Wales, Alaska. Albert Hill Fay. An illustrated description of geographic and climatic conditions and of the geology and mining prospects. 4000 w. Bul Am Inst of Min Engrs—Sept., 1907. No. 87728 C.

Utah.

The Mining and Mineral Resources of Utah. John Dern. Considers a few of the leading mining districts. The minerals of importance are those of gold, silver, copper, and lead, but other deposits of value are found. 4000 w. Am Min Cong—1906. No. 87365 N.

Vanadium.

The Present Source and Uses of Vanadium. J. Kent Smith. Shows its great industrial importance, its effect on steel, and considers the present sources of supply. 1200 w. Bul Am Inst of Min Engrs—Sept., 1907. No. 87723 C.

Wisconsin.

Mining and Mineral Resources of Wisconsin. W. O. Hotchkiss. Describes the geological formations of the state, the ore deposits and their development. Lead and zinc ores are principally considered, but iron and other metallic minerals are of value. 1200 w. Am Min Cong—1906. No. 87370 N.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accident.

Shrewsbury Railway Accident. An illustrated account of a serious accident in England. 900 w. Engng—Oct. 18, 1907. No. 87960 A.

Non-Stop Run.

Longest Non-Stop Run on Great Western Railway. Charles Rous-Marten. An account of a run from Paddington to Fishguard over the new route of the Anglo-Irish mail service. 1500 w. Engr, Lond—Sept. 27, 1907. No. 87530 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

The K Triple in Modern Brake Service. John P. Kelly. Remarks on present requirements of air brakes, with illustrated description of this improved design and its working. Also discussion. 11800 w. Pro Cent Ry Club—Sept. 13, 1907. No. 87864 C.

The Westinghouse Air Brake Company. —Quick-Service Triple Valve. An illustrated description of the features of Type K triple valve, outlining what it is designed to accomplish. 7000 w. Pro Ry Club of Pittsburgh—May, 1907. No. 87711 C.

Air Pipes.

Broken Air Pipes. G. W. Kiehm. Suggestions for repairing pipes in the air-brake equipment. 1500 w. Ry & Loc Engng—Oct., 1907. No. 87318 C.

Boiler Inspection.

New York Laws for Locomotive Boiler Inspection. Laws requiring thorough inspection to be made of all boilers and fittings of steam locomotives used on railroads. 2500 w. Boiler Maker—Oct., 1907. No. 87323.

Locomotive Boiler Inspections in New York State. Gives the amended requirements that went into effect Sept. 1st, with the regulations for inspecting, testing, etc. 3000 w. R R Gaz—Sept. 13, 1907. No. 87907.

Dynamometer Cars.

New Dynamometer Car for the Pennsylvania Railroad. Illustrated description of the car and its equipment and operation. 2500 w. Eng News—Oct. 17, 1907. No. 87741.

North-Eastern Railway Dynamometer Car. Illustrated description of a car for this English road. 1200 w. Engr, Lond—Oct. 4, 1907. No. 87596 A.

Fireboxes.

Methods of Obtaining Flexibility in Locomotive Fireboxes. Shows the advantage of flexibility and considers methods of securing it. Ills. 2500 w. Boiler Maker—Oct., 1907. No. 87324.

Grade Assistance.

Cable-Assisted Trains Upon a Scottish Railroad. Brief illustrated description of a novel means of assisting trains up a severe gradient in use at the Cowlairs Incline in Scotland. 600 w. Sci Am Sup—Oct. 5, 1907. No. 87479.

Locomotive Coals.

Locomotive Coals. A Jacobsen. An account of results of tests made by the Danish State railways. Ills. 4000 w. Engr, Lond—Oct. 18, 1907. No. 87962 A.

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Locomotive Performance.

Recent Locomotive Work on the French Northern Railway. Charles Rous-Marten. An account of runs showing the ordinary work on this railway. 3000 w. Engr, Lond—Sept. 20, 1907. No. 87346 A.

Locomotives.

Curiosities of Locomotive Design. Angus Sinclair. From "Development of the Locomotive Engine." Illustrates and describes peculiar designs. 1800 w. Ry & Loc Engng—Oct., 1907. No. 87316 C.

Seth Wilmarth's Locomotives. C. H. Caruthers. An account of works once existing in Boston, Mass., and the engines built. Ills. 18000 w. R R Gaz—Sept. 27, 1907. No. 87916.

The Development of the American Locomotive. Report of the Committee on Science and Arts on the contribution of the Baldwin Locomotive Works. Ills. 5500 w. Jour Fr Inst—Oct., 1907. No. 87758 D.

Locomotive Exhibit at the Milan Exposition. Abstract translation of an article by M. L. Georges, in the *Revue Generale*. Ills. 1600 w. Ry & Engng Rev—Oct. 5, 1907. No. 87497.

Locomotives at the Jamestown Exposition. Illustrated description of the exhibits of the Baldwin Locomotive Works and the American Locomotive Company. 1500 w. Ry Age—Oct. 4, 1907. No. 87494.

Details of Mallet Articulated Compound Locomotive. Detailed description of the interesting special features. Ills. 4000 w. R R Gaz—Oct. 4, 1907. No. 87923.

Pusher Locomotives of the Mallet Duplex Type for the Erie Ry. Illustration with description. 1000 w. Eng News—Oct. 3, 1907. No. 87420.

Pacific Locomotive for the Lake Shore and Michigan Southern. Compares them with the prairie engines which have been used up to the present, and gives an illustrated description. 2500 w. R R Gaz—Sept. 6, 1907. No. 87902.

Pacific Type Locomotives. Illustrated description of new engines for freight and passenger service on the Richmond, Fredericksburg & Potomac R. R. 600 w. Am Engr & R R Jour—Oct., 1907. No. 87419 C.

Four Cylinder Simple Express Locomotives; Great Western Railway. The latest type of locomotive for hauling express passenger traffic on this line is illustrated and described. 500 w. R R Gaz—Oct. 4, 1907. No. 87924.

Compound Ten-Wheel Locomotives for the Buenos Ayres Western Railway. Illustrated description of compound passenger and freight locomotives, having special features of interest. 600 w. R R Gaz—Sept. 6, 1907. No. 87904.

Royal Bavarian 4-4-2. Illustration with brief description of a type in use on the continent of Europe. 500 w. Ry & Loc Engng—Oct., 1907. No. 87317 C.

An Interesting Locomotive. Illustrates and describes an example of the latest construction of light passenger engines for the Austrian State Railways, to serve main line feeders. 600 w. Ry & Engng Rev—Oct. 5, 1907. No. 87498.

Express Locomotive for the Prussian State Railways. Illustrated description of the latest type of six-coupled express locomotive, fitted with the Schmidt type of smoke-tube superheater. 1500 w. Plate. Engng—Oct. 11, 1907. No. 87836 A.

Locomotive Tests.

A Method of Plotting Locomotive Characteristics. Lawford H. Fry. Gives a diagram showing a system of plotting the results of locomotive tests to give a series of characteristic curves which cover the whole range of operation. 2000 w. Am Engr & R R Jour—Oct., 1907. No. 87416 C.

The Results of Tests on Tank Locomotives Using Superheated Steam (Versuchs- und Betriebsergebnisse mit Heissdampf-Tenderlokomotiven). Herr Müller. Gives tables and curves showing the performance of the 10-wheel locomotives of the Prussian state railways. Ills. 3500 w. Verkehrstech Woche u Eisenbahntech Zeitschr—Sept. 7, 1907. No. 87627 D.

Motor Cars.

Steam Motor Cars. Illustrates and describes motor cars recently put in service on the Intercolonial Railway of Canada. 1000 w. Am Engr & R. R. Jour—Oct., 1907. No. 87417 C.

Mountain Railway.

The Puy-de-Dome Mountain Railway. Illustrated description of this railway in France, in which the locomotive is assisted by the Fell friction-grip, centre-rail system. 1000 w. Eng News—Oct. 10, 1907. No. 87551.

Refrigerator Cars.

Ventilating Refrigerator Cars. Illustrates and describes the Garland Ventilator and the principle on which it is based. 1500 w. Ice & Refrig—Oct., 1907. No. 87433 C.

Shops.

New Railway Shops (Neuere Eisenbahnwerkstätten). Herr Müller. A series of articles descriptive of the shops of the Prussian state railways, the first dealing with the Oppum shops at Krefeld. Ills. 7000 w. Serial. 1st part. Verkehrstech Woche u Eisenbahntech Zeitschr—Sept. 14, 1907. No. 87628 D.

The Shops of the Swiss State Railways and Their Extension (Les Ateliers des Chemins de Fer Fédéraux, à Yverdon, et

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leur Agrandissement). M. G. Guillemin. Illustrated description of buildings and equipment. 4950 w. Bull Tech d l Suisse Rom—Sept. 25, 1907. No. 87608 D.

Steam v. Electricity.

Steam Locomotive versus Electric Locomotive. Max Toltz. Aims to show that the steam locomotive properly improved is by far more economical than the electric locomotive. Ills. Discussion. 18300 w. Pro N Y R R Club—Sept. 20, 1907. No. 87760.

Steel Cars.

All-Steel Passenger Cars. Illustrates and describes the cars to be operated in the tunnels and subways of the Hudson Companies in New York city and vicinity. 1500 w. Am Engr & R R Jour—Oct., 1907. No. 87418 C.

Superheating.

Are We Superheating Along Correct Lines? Editorial discussion of this subject. 1100 w. Ry & Engng Rev—Oct. 5, 1907. No. 87499.

Tires.

Causes of Defects and Failures of Steel Tires. George L. Norris. Read before the W. Ry. Club. An illustrated discussion of this subject. 2500 w. R R Gaz—Oct. 25, 1907. Serial. 1st part. No. 87931.

Wheel Loads.

Greater Loads on Rails. H. V. Wille. Gives accurate data showing the great increase in weight in rolling stock since 1885. 1700 w. Ir Age—Oct. 3, 1907. No. 87379.

Wheel Stresses.

Pressure of Locomotive Wheels Against the Rails. George L. Fowler. A report of recent investigations of lateral stresses. 500 w. R R Gaz—Sept. 20, 1907. No. 87910.

Valve Gear.

Express Passenger Engine, Midland Railway—The Valve Gear. Illustrates and describes the valve gear of the latest passenger engine for this line. 500 w. Engr, Lond—Sept. 20, 1907. No. 87348 A.

NEW PROJECTS.

Brazil.

The Survey of the Madeira and Mamore R. R. in Brazil. Ernest H. Liebel. Gives a general description of the territory through which the proposed line will pass, and reports the experiences of the engineers on the preliminary exploration survey. 4000 w. Eng News—Oct. 24, 1907. No. 87875.

Great Western Ry.

New Route Between Bristol and Birmingham. An illustrated description of a new direct route scheme of the Great Western Ry. 2800 w. Engr, Lond—Oct. 11, 1907. No. 87840 A.

Northern Pacific.

The New Tacoma-Tenino Line of the Northern Pacific. H. Cole Estep. An illustrated description of this section of the Northern Pacific. 1000 w. R R Gaz—Oct. 11, 1907. No. 87927.

Philippines.

Philippine Railroad Building with Filipino Builders. Outlines the work and gives an illustrated description of construction work. 3500 w. R R Gaz—Sept. 13, 1907. No. 87909.

Portland and Seattle.

The Portland & Seattle Railway. H. Cole Estep. Illustrates and describes a road being built to get a direct low-grade freight between eastern Washington and the coast. 2000 w. R R Gaz—Sept. 27, 1907. No. 87917.

South Africa.

The Amabele-Butterworth Railway, South Africa. Brief description of this new line and its construction. Its length is 78 miles. 1500 w. Eng Rec—Oct. 5, 1907. No. 87445.

Southern Railway.

The Southern's New Line from Jasper, Ind., to French Lick. Illustrated description of the construction of a new line, 24.8 miles in length. 1400 w. R R Gaz—Sept. 6, 1907. No. 87903.

Western Pacific.

Engineering Features of the Western Pacific Railway. George P. Low. Map, profile, and illustrations, with description. 4500 w. Eng Rec—Sept. 28, 1907. No. 87304.

PERMANENT WAY AND BUILDINGS.

Car Dumping.

New Car-Dumping Devices (Neuere Wagenkipper). Georg v. Hanffstengel. Illustrated detailed description of three installations for dumping coal and ore cars bodily, recently developed in Germany. 4400 w. Zeitschr d Ver Deutscher Ing—Sept. 28, 1907. No. 87653 D.

Concrete Ties.

Experiments with Reinforced Concrete Ties in America. W. M. Camp. Describes some of the experiments made with these ties. Ills. 4000 w. Bul Int Ry Cong—Sept., 1907. No. 87427 E.

Earth Slides.

Earth Slides. From a bulletin contributed by H. Rohwer, to the Am. Ry Engng. & Main. of Way Assn. Describes slides coming to the notice of the writer and the remedies. 1700 w. Eng Rec—Oct. 5, 1907. No. 87446.

The Otavi Railway in South Africa. The Longest 24 in. Gage Railway in the World. Illustrates and describes a recently completed road of light construction. 2000 w. Eng News—Oct. 10, 1907. No. 87548.

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Rails.

Wheel-Loads and Rail-Weights. George Sherwood Hodgins. Shows the interrelation of rail weight and wheel load, giving a comparison of the rise and fall of rail sections with the development of the locomotive. Ills. 2500 w. Cassier's Mag—Oct., 1907. No. 87386 B.

Scales.

The Standard Track Scale. Illustration and brief description of a 600-ton suspension steel frame scale. 700 w. Ir Age—Oct. 3, 1907. No. 87378.

Shops.

See under Motive Power and Equipment.

Terminals.

A Few Points on Railroad Terminals, with Special Reference to Roundhouses. R. E. W. Hagarty. Deals with the general layout of terminal yards and discusses some of the structures. 2500 w. Trans Eng Soc, Univ of Toronto—No. 20. No. 88132 N.

Timber.

See under Civil Engineering, Materials of Construction.

Track Reversal.

Track Work Involved in the New York Central's Reversal of the Direction of Traffic. Describes the work involved. 1800 w. R R Gaz—Sept. 13, 1907. No. 87908.

Tunnels.

See under Civil Engineering, Construction.

Widening.

Widening Operations on the Great Central Railway. An account of extensive improvements on this British railway. 1000 w. Engr, Lond—Oct. 18, 1907. No. 87963 A.

Yards.

The Pitcairn Yard of the Pennsylvania Railroad. Plan and description. 4000 w. Eng Rec—Oct. 12, 1907. No. 87569.

TRAFFIC.

Bills of Lading.

The Uniform Bill of Lading. R. L. Ardrey. Analysis of the hearing before the Interstate Commerce Commission. 2000 w. Ir Age—Nov. 7, 1907. No. 88138.

Car Efficiency.

Car Efficiency. Addresses by E. B. Boyd, and Arthur Hale, before the Traffic Club of Chicago. 5000 w. R R Gaz—Nov. 1, 1907. No. 88028.

Demurrage.

Reciprocal Demurrage. W. Heyward Drayton. Address before the Traffic Bureau of the Illinois Mfrs. Assn. Considers the questions of non-furnishing of cars, and the failure to move a car a specified number of miles per day. 1600 w. Ry Age—Oct. 4, 1907. No. 87495.

Freight Rates.

Do Reductions in Freight Rates Benefit the Masses? From a pamphlet concerning the effects of reductions of freight and passenger rates issued by Joseph M. Brown. Shows that reduction in freight rates brings no benefit to the masses of the people. 4000 w. Ry Age—Oct. 4, 1907. No. 87496.

Steam vs. Electric.

Electric Railway Competition. Ray Morris. Gives a summary of information obtained, discussing the results shown and the development of interurban lines. 2500 w. R R Gaz—Oct. 11, 1907. No. 87929.

MISCELLANY.

Algerian Railways.

African Railroads in Algeria and Tunis. From *Moniteur Industriel.* Reviews the history of these lines. 2000 w. R R Gaz—Oct. 4, 1907. No. 87926.

Australian Railways.

Australian Railways (Les Chemins de Fer Australiens). Paul Privat-Deschanel. Gives a history of their development and a general description of permanent way, stations, rolling stock, traffic, new projects, etc. Ills. Serial. 1st part. 5500 w. Génie Civ—Sept. 7, 1907. No. 87609 D.

British Railways.

British Railway Economics. Editorial discussion of the returns issued by the Board of Trade. 3000 w. Engng—Oct. 18, 1907. No. 87958 A.

Italian Railways.

Travel Notes from Italy, Referring Especially to the Milan Exposition, 1906 (Reisebeobachtungen aus Italien und insbesondere von der Mailänder Ausstellung 1906). Herr Cauer. The first part of the serial discusses the transportation facilities of the exposition and describes some of the exhibits. Ills. 4500 w. Serial. 1st part. Glaser's Ann—Sept. 15, 1907. No. 87638 D.

Regulation.

The Railroad Problem. Robert Mather. From an address before the Chicago Assn. of Commerce. Discusses the subject of state regulation. 5800 w. R R Gaz—Oct. 18, 1907. No. 87930.

Union Pacific.

The Growth of the Union Pacific and Its Financial Operations. Thomas Warner Mitchell. An account of its organization and reconstruction, its growth and activities. 14000 w. R R Gaz—Sept. 13, 1907. No. 87906.

Water vs. Rail.

The Complementary Nature of Water Transportation as Allied to Transportation by Rail. J. T. Harahan. An address before the deep waterway convention, at Memphis, Tenn. 1700 w. Ry Age—Oct. 11, 1907. No. 87580.

We supply copies of these articles. See page 559.

STREET AND ELECTRIC RAILWAYS

Car Barn.

See under Reinforced Concrete, Civil Engineering, Construction.

Cars.

Pressed Steel Pay-as-You-Enter Cars for Montreal. Illustrated detailed description of new cars. 800 w. St Ry Jour—Oct. 5, 1907. No. 87492.

Rolling Stock for the Washington, Baltimore & Annapolis Electric Railway. E. P. Roberts. Illustrated description. 2500 w. Elec Ry Rev—Oct. 12, 1907. No. 87579.

Catenary Lines.

Recent Improvements in Catenary Line Construction and Methods of Installation. Gives details of the latest work of the General Electric Co. in line construction, describing designs and methods of installation. 4000 w. St Ry Jour—Oct. 26, 1907. No. 87932.

Control Apparatus.

Recent Improvements in Control Apparatus for Railway Equipments. F. E. Case. Describes new features of multiple-unit and hand control. 1500 w. St Ry Jour—Oct. 19, 1907. No. 87816.

Croydon.

Croydon Corporation Tramways. History and illustrated description of these lines and their equipment. 3800 w. Tram & Ry Wld—Oct. 3, 1907. No. 87825 B.

Depreciation.

Where Maintenance Ends and Depreciation Begins. J. H. Neal. Read before the Am. St. & Int. Ry. Acc. Assn. Discusses the relations between maintenance and depreciation. 1200 w. St Ry Jour—Oct. 19, 1907. No. 87814.

Equipment Depreciation and Renewal. William Mahl. Gives statements bearing on equipment renewals and replacements, discussing the difficulties of keeping equipment accounts. 2500 w. R R Gaz—Oct. 11, 1907. No. 87928.

Electrification.

The Field for Electricity on Steam Railways. Frederick Darlington. Reviews the progress of electricity as a motive power on railroads, showing its superiority and reliability for certain kinds of work, and also its economy. 3500 w. Ry Age—Oct 18, 1907. No. 87796.

Equipment.

Electrical Equipment of Main Line Railways in Europe. Philip Dawson. Discusses progress abroad in heavy electric traction, particularly in the field of single-phase motors. Ills. 6800 w. St Ry Jour—Oct. 12, 1907. No. 87782.

Erie R. R.

Single-Phase Electric Motive Power on the Rochester Division of the Erie Railroad. W. N. Smith. Illustrated detailed description. 9000 w. Eng Rec—Oct. 12, 1907. No. 87567.

Single-Phase Electric Traction on the Rochester Division of the Erie R. R. W. N. Smith. Illustrated detailed description of a noteworthy installation on the single-phase system. 9000 w. Eng News—Oct. 17, 1907. No. 87738.

European.

See under Equipment.

Freight Traffic.

Light Freight Handling by Electric Lines. P. P. Crafts. Read before the Am. St. & Int. Ry. Assn. Considers methods of making the freight traffic successful 2500 w. St Ry Jour—Oct. 26, 1907. No. 87933.

Freight Service on Electric Railways. H. H. Polk. Read before the Am. St. & Int. Ry. Assn. Discusses methods, rates, equipment and related matters. 3000 w. St. Ry Jour—Oct. 26, 1907. No. 87934.

Locomotives.

Electric Locomotives of the Pennsylvania Railroad. Illustrated description of the two direct-current locomotives now undergoing tests. 1200 w. R R Gaz—Sept. 20, 1907. No. 87913.

See under Equipment, N. Y., N. H. & H. R. R., New York Central R. R., Long Island R. R., and West Jersey and Seashore R. R., and West Shore R. R.

Long Island R. R.

Operating Features of the Long Island City Power Station of the Pennsylvania Tunnel and Terminal Railroad Co. Several articles on the equipment and electrical operation of the Lond Island R. R. Ills. 12000 w. St Ry Jour—Oct. 12, 1907. No. 87778.

New York Central R. R.

General Features of the New York Central Electrification. A collection of articles dealing especially with the operating practice of stations, sub-stations, etc., and of methods of conducting transportation. Fully illustrated. 30600 w. St Ry Jour—Oct. 12, 1907. No. 87776.

New York City.

Rapid Transit Conditions in New York. Diagrams and interesting information from the report for 1906 of the Board of Rapid Transit Railroad Commissioners for the City of New York. 3500 w. R R Gaz—Sept. 20, 1907. No. 87914.

We supply copies of these articles. See page 559.

N. Y., N. H., & H. R. R.

Operation of Electric Locomotives by the New Haven Railroad. On the operation of the combined single-phase, direct-current locomotives. 8500 w. St Ry Jour—Oct. 12, 1907. No. 87779.

Power Plants.

See under Central Stations, Electrical Engineering, Generating Stations.

Rails.

The Use of the T-Rail in Cities. C. Gordon Reel. Read before the Am. St. & Int. Ry. Assn. Gives an account of satisfactory use at Kingston, N. Y. Diagrams. 1000 w. St. Ry Jour—Oct. 26, 1907. No. 87994.

Service Plant.

Line and Track Service Plant, Brooklyn Rapid Transit Company. Plans and description of interesting details of an elaborate plant under construction. 1500 w. Elec Ry Rev—Oct. 5, 1907. No. 87482.

Shops.

New Shops and Car Houses at Knoxville—Shop Practice. Illustrated article giving details regarding these shops and the shop practice. 1500 w. St Ry Jour—Oct. 5, 1907. No. 87491.

Signals.

Solenoid Signals on the Manhattan Elevated. Illustrates and describes the semaphore block signals recently put in service on curves. 800 w. R R Gaz—Sept. 20, 1907. No. 87911.

Single Phase.

General Notes on the Development and Future Prospects of the Application of Single-Phase Current to Electric Railroads (Allgemeine Gesichtspunkte über die Entwicklung und die Aussichten des Einphasenstrom-Bahnbetriebes). A. Heyland. Considers the problem both theoretically and practically. 3200 w. Serial. 1st part. Elektrotech Zeitschr—Sept. 12, 1907. No. 87657 D.

Steel Ties.

Steel Tie and Concrete Construction on Utica and Mohawk Valley Railway System, Utica, N. Y. M. J. French. Illustrates and describes recent work, giving cost. 2500 w. St Ry Jour—Oct. 12, 1907. No. 87774.

Steel Ties in Germany. Dr. Ing. N. C. A. Haarmann. Reports the increasing use of steel ties, illustrating and describing the writer's "hook plate." 1200 w. R R Gaz—Sept. 29, 1907. No. 87915.

Structures.

The Influence of the Design of Railway Structures on Economy of Operation. H. T. Campion and William McClellan. Notes on materials and design, particularly in connection with the smaller systems. Ills. 3500 w. St Ry Jour—Oct. 19, 1907. No. 87819.

Subways.

Paris Subway Stations. George B. Ford. Illustrates and describes some of the entrances to subway stations in Paris, comparing them with work in London and New York. 1600 w. Am Archt—Oct. 15, 1907. No. 87452.

The Market Street Subway, Philadelphia. Illustrated detailed description. 2500 w. Eng Rec—Oct. 12, 1907. No. 87564.

Systems.

Which Is the Best Electric Railroad System? C. L. de Muralt. Editorial letter aiming to explain the differences between the three rival electric railroad systems. 3500 w. R R Gaz—Sept. 13, 1907. No. 87905.

Timber.

See under Civil Engineering, Materials of Construction.

Track Maintenance.

Care of Electric Railway Tracks. George L. Wilson. Read before the Am. St. & Int. Ry. Engng. Assn. Suggestions for the care of interurban and city tracks. 3000 w. Eng Rec—Oct. 19, 1907. No. 87788.

Track Reconstruction.

Track Reconstruction by the Chicago Electric Traction Lines. Illustrates and describes the three types of construction in the work already done, and the general characteristics of the work. 1200 w. Elec Ry Rev—Oct. 5, 1907. No. 87481.

The Rehabilitation of the Tracks of the Chicago Street Railway. An illustrated description of the general features of the work required by the city council. 3500 w. Eng Rec—Oct. 19, 1907. No. 87786.

Trucks.

Long Wheel-Base Trucks. R. L. Acland. Read before the Munic. Tram. Assn., at Manchester, Eng. Presents the merits of these trucks for street cars. Ills. 3000 w. Elec Engr, Lond—Sept. 27, 1907. No. 87512 A.

Practical Views on Trucks for Electric Motor Service. Franklyn M. Nicholl. Discusses the practicability of the principles of the M. C. B. truck in their application to electric service requirements. 800 w. Elec Ry Rev—Oct. 19, 1907. No. 87813.

West Jersey & Seashore R. R.

The Power Station Practice of the West Jersey & Seashore Railroad. With related articles describing the electrical operation of this line. Ills. 9000 w. St Ry Jour—Oct. 12, 1907. No. 87780.

West Shore R. R.

Electrical Operation on the West Shore Railroad. Illustrated account of the operation between Utica and Syracuse, N. Y. 5000 w. St Ry Jour—Oct. 12, 1907. No. 87777.

We supply copies of these articles. See page 559.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.

Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Verkehrstechnische Woche und Eisenbahntechnische Zeitschrift. *w.* Berlin.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin